

**Impacts of the Global Financial Crisis
on an Emerging Market:
The Case of Vietnam**

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Statement of Authentication

The work in the thesis has been prepared by me to partially fulfil the requirements of the Doctor of Business Administration at the University of Western Sydney.

I declare that the work is a result of my own research except where acknowledgement of another's work is made. It is an original work and I have not submitted this material, either in whole or in part, for a higher degree at any other institution.

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Date:

19 March 2013

Abstract

Global equity markets have become increasingly integrated in recent decades. This global integration and rapid information transmission suggests highly significant linkages across markets. In the literature, researchers investigate three dominant market linkages: co-integration, causality and contagion. Of these linkages, the first and second refer to a long-run and short-run relationship respectively while the third relates to the transmission of a shock among the markets during crisis periods.

Unlike other crises in recent decades, the Global Financial Crisis (GFC) in mid-2007 originated in the United States (US), the largest and most influential market in the world, and had severe effects on global equity markets. Moreover, the crisis appeared to change linkages among global markets. The extent to which the GFC has affected global equity markets, particularly markets that do not have strong international trade links with the US, and whether global equity-market linkages have been influenced by the GFC are of increasing interest to researchers and practitioners.

The purpose of the thesis is to investigate the extent to which the GFC has affected the Vietnamese equity markets and its linkages to global equity markets. Despite the significant growth in market capitalization over the last 10 years, studies on the Vietnamese equity market are sparse in the existing literature and there is a lack of research taking into account the influence of the GFC on the market as well as on its cross-market linkages. Specifically therefore, the thesis examines impacts of the GFC on the Vietnamese equity market at market levels and on its linkages - including both short-run and long-run linkages - to global markets. The linkages are based on two foundational theories; namely Purchasing Power Parity Theory and the Modern Portfolio Theory that are commonly discussed in the literature. Also examined is whether a shock from the GFC spread to the Vietnamese equity market, and if so, how and where the shock originated.

To answer these issues, the thesis employs nine equity-market indices - Hong Kong, Japan, Korea, Singapore, Taiwan, the US, Malaysia, Thailand and Vietnam. These countries are selected for the fact that they have continuously maintained leading positions in the FDI

flows of Vietnam in recent years. The period of study is from 28/7/2000 to 31/12/2010; the start date being the first trading day of the Vietnamese equity market. The markets are separated into two groups, namely advanced markets (Hong Kong, Korea, Japan, Singapore, Taiwan and the US) and emerging markets (Malaysia, Thailand and Vietnam). Three main groups of empirical testing models are used to explore the impacts of the GFC on the Vietnamese equity markets. Firstly, co-integration tests are used to examine the long-run linkages between and among the markets. Second, causality tests are used to explore the causal or short-run linkages. Finally, the contagion effect is investigated by employing constant and dynamic conditional correlation tests. In these tests, the pre- and post-analysis technique is performed to examine the impacts of the GFC during sub-periods.

The empirical results of the thesis find much evidence in favour of the co-integration relationship between Vietnam and other markets during the entire sample and sub-periods - for example, the co-movement of Vietnam–Hong Kong, Japan–US during the entire period; and Vietnam–Japan, Vietnam–Taiwan during the pre-crisis period. However, the results overall are not consistent among the three bivariate co-integrating tests employed in the thesis. Long-run co-movements are also evident in the relationships within the entire market, but not within the three emerging markets of Vietnam, Thailand and Malaysia.

A number of causal linkages are explored in the relationship between and among the Vietnamese and other selected markets. The results show the feedback relationships between Vietnam and each of Hong Kong, Singapore and Korea during the entire period and sub-periods. In addition, we find that Vietnam is not Granger-caused to the US during the pre-crisis period; however, the mono-directional relationship from the US to Vietnam is revealed during the post-crisis period. The multivariate Granger causality is found in the relationships among the groups of markets during the entire period and pre-crisis period - for example, Vietnam is influenced by the US, Hong Kong and Malaysia. During the post-crisis period, Vietnam is Granger-caused by the co-integrating vectors and constant terms rather than lagged values of the endogenous variables in the dynamic structure. We believe that these results are due to our parsimonious criterion in selecting the lag-length criteria and a relatively short time frame during the post-crisis period (1/3/2009–31/12/2010) in comparison to the pre-crisis period (28/7/2000–31/8/2008).

The empirical findings on the contagion effect are found in the relationships between the Vietnamese and other markets. The constant conditional correlation reveals that during the pre-crisis period, the highest correlation is found between Vietnam and Japan; however, after the crisis, it switches to the relationship between the US and Vietnam. In addition, among the markets, Japan is considered the first market influenced by the GFC because it has the highest correlation with the US. The dynamic conditional correlation also highlights the transmission of the GFC to the entire market. Among these markets, Hong Kong and Singapore are found to play important roles in transmitting the shock of the subprime mortgage crisis from the US to the other markets during the pre-crisis period; however, Japan is found to play this role during the crisis period. The results also indicate a significant shock to the Vietnamese equity market during the crisis period.

Preface

The preliminary empirical findings of the thesis have been presented at the conferences and published in the journals below:

Conferences

‘The long-run relationship among the Southeast Asian equity markets’, *International Conference on Economics Trade and Development*, Bangkok, Thailand, 14–15 April 2012 (co-author K. Daly).

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Journals

‘The impacts of the Global Financial Crisis on Southeast Asian equity markets integration’, *International Journal of Trade, Economics and Finance*, vol. 3, no. 4, pp. 299 – 304 (co-author K. Daly).

‘Transmission of the Global Financial Crisis to the East Asian equity markets’, *International Journal of Economics and Finance*, vol. 5, no. 5, pp. 172 – 183 (co-authors K. Daly and C. Ellis).

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List of Abbreviations

ADF	Augmented Dickey Fuller
AFC	Asian Financial Crisis
AIC	Akaike Information Criterion
ARCH	autoregressive conditional heteroskedasticity
ASEAN	Association of Southeast Asian Nations
ATC	at-the-closing order
ATO	at-the-opening order
CCC	constant conditional correlation
DCC	dynamic conditional correlation
ECT	error correction term
FDI	foreign direct investment
GDP	gross domestic product
GFC	Global Financial Crisis
GARCH	generalised autoregressive conditional heteroskedasticity
HK	Hong Kong
HOSE	Ho Chi Minh Stock Exchange
JP	Japan
KR	Korea
LO	limit order
LPIT	Law of Personal Income Tax
MGARCH	multivariate generalised autoregressive conditional heteroscedasticity
ML	Malaysia
MO	market order
MPT	modern portfolio theory
PP	Phillips–Perron
PPP	purchasing power parity
REE	Refrigeration Electrical Engineering Joint Stock Company
SACOM	Saigon Cable and Telecommunication Material Joint Stock Company

SCGT	South China Growth Triangle
SG	Singapore
SIC	Schwarz Information Criterion
SSC	States Securities Commission
SSC	State Securities Commission of Vietnam
std dev.	standard deviation
TL	Thailand
TW	Taiwan
UK	United Kingdom
US	United States
VAR	vector autoregression/vector autoregressive
VEC	Vector Error Correction
VN	Vietnam
VND	Vietnamese Dong (currency)
WTO	World Trade Organization

Chapter 1: Introduction

1.1 Overview

One of the salient features of international financial markets in recent decades is the significant increase in equity-market linkages. This increase is attributed not only to a global integration tendency but also to the rapid transmission of information across markets, meaning that a shock in one country can spread to other markets that may not have interdependent linkages or share geographical proximity to the host country. This issue has been developing in the literature as crises have occurred and been transmitted rapidly to the global market in recent decades.

In early studies, equity-market linkages were mostly explained as a result of international trade and financial linkages (Phylaktis and Ravazzolo 2002; Khalid and Kawai 2003), and fundamental economic linkages (Kearney 2000; Pretorius 2002). However, in the 1990s, as a series of crises originated in different parts of the world and then spread to regional and global markets, several researchers argued that fundamental factors did not seem to provide thoughtful explanations of global market linkages (Masson 1999; Pericoli & Sbracia 2003; Dungey & Tambakis 2005). Thus, other factors associated with irrational behaviour, such as liquidity problems, imperfect information and multiple equilibria, are of interest to researchers.

Equity markets in emerging countries are often argued to be incomplete, fragile and illiquid, with several drawbacks such as weaknesses in market governance, lack of appropriate regulations, and high vulnerability in investor behaviour (Antoniou, Ergul & Holmes 1997; Daly 2003; Kallinterakis 2009). Hence, these markets are more sensitive to a shock than developed markets. However, due to different market sizes, structures and developments, emerging markets are influenced differently by crises (Forbes & Rigobon 2002; Marcal et al. 2011; Kenourgios & Padhi 2012).

The Global Financial Crisis (GFC) originated in the United States (US) in mid-2007, and is considered one of the most severe financial crises in history. It is often compared to the Great Depression of the 1930s because of its severity and global reach (Kurth 2011; Sen 2011;

Shachmurove 2011; Dwyer & Lothian 2012). The GFC intensified in mid-2008 and caused sharp declines in global equity markets until the first quarter of 2009.¹ Due to its severity and global reach, the GFC has had a significant influence on global equity markets and has caused fundamental changes in linkages among both emerging and advanced markets. A large number of studies have examined the impacts of the GFC on advanced and major emerging markets, rather than small young emerging markets. In the era of global market integration, emerging markets have been attracting growing interest from international investors wanting to maximise their diversification benefits. Therefore, the extent to which the GFC has affected small and young emerging markets and their linkages to global markets needs to be explored, particularly in young emerging markets with high growth rates and potential returns.

The central pillar of the thesis is to investigate the impacts of the GFC on the Vietnamese equity market and its linkages to other international markets. There are three reasons for selecting the Vietnamese equity market. Firstly, foreign indirect investment flows into the Vietnamese equity market have increased dramatically in the last decade, rising from US\$115 million in 2005 to US\$6,243 million in 2007 and US\$2,382 in 2010 (World Bank 2010). This suggests an increasing global integration of the market. Second, although the Vietnamese equity market has achieved significant growth rates in recent years in terms of market capitalisation and market sizes. The Vietnamese market was severely affected by the GFC, its market capitalisation had declined over 60 per cent by the end of 2008, although it recovered slightly in 2009. This raises increasing concerns about the spread of the GFC through the market as well as its co-movement towards global markets. Third, empirical studies of the Vietnamese equity market are sparse in the existing literature, and moreover, there is a lack of studies investigating the impacts of the GFC on the Vietnamese equity market and its linkages to global equity markets.

In this thesis, four issues associated with the research objective above are clarified. Firstly, the impacts of the GFC on the Vietnamese equity market are explored by investigating significant changes in the market environment over the crisis period. Based on the literature, we identify factors in the Vietnamese equity market that can influence its cross-market linkages. Second, we examine whether long-run and short-run linkages exist between and among the Vietnamese and global markets. Third, given that there are some significant changes in equity-market linkages in vulnerable periods, the effects of the GFC on equity-market

¹Further discussions of the GFC can be found in Chapter 2 of this thesis.

linkages between and among the Vietnamese and global markets are examined. Finally, the transmission mechanism of a shock caused by the GFC to the Vietnamese and global markets is taken into consideration.

The remainder of this chapter provides an overview of the key issues of the thesis with regard to the background (section 1.2), research questions and methodology (section 1.3), scope and contribution (section 1.4), and organisation (section 1.5).

1.2 Background

1.2.1 Financial crises

In early studies, the term ‘financial crisis’ was defined with regard to banking panics positing that a financial crisis would originate from a sharp decline in money supply leading to severe effects on economic activities (Friedman & Schwartz 1963). Later, a broader view of financial crises was proposed in relation to the nature and different patterns of a crisis (Minsky 1972; Kindleberger 1978; Minsky 1982) as well as asymmetric information (Gertler 1988; Mishkin 1992). However, these definitions are not rigorous in terms of the characteristics and consequences of financial crisis. A study by Mishkin (1992) provides a precise definition, stating that a financial crisis is a disruption to financial markets leading to an inefficient channelling of funds in financial markets and driving aggregate economic activity away from an equilibrium position.

The consequences of financial crises are documented by many researchers. For example, Mishkin (1992) discusses the negative effects of a financial crisis by stating that a financial crisis results in problems in adverse selection and moral hazard and then leads to declines in aggregate economic activities.² Another study by Hahn and Mishkin (2000) describes a crisis via two stages: (1) the run-up to a currency crisis; and (2) from currency crisis to financial crisis. More details of the effects can be widely seen in the literature (for example, Ariff and Abubakar (1999); Fallon and Lucas (2002); Okumus and Karamustafa (2005); Claessens et al. (2010)).

²Adverse selection problems implies the selection of a potential bad credit risk that may produce a bad (adverse) outcome. Moral hazard problems are the result of a conflict of interest between lenders and borrowers, as lenders are subject to hazards if borrowers’ activities are undesirable (immoral). More details of the consequences of financial crises are discussed in Chapter 2 of this thesis.

The GFC was one of the most severe market events in the history of financial development. Dabrowski (2010) shows that the GFC originated in the US in mid-2007 after the eruption of the subprime crisis. The crisis then rapidly transmitted to advanced countries (for example, Ireland, the United Kingdom, Iceland, Spain) in early 2008 and emerging countries (for example, Hungary, Latvia, Romania) in mid-2008 and early 2009. Similarly, Claessens et al. (2010) indicate that many advanced economies and other countries with strong financial linkages suffered losses in early 2008 and then the crisis spread to other countries in the third quarter of 2008. The crisis severely affected the global economy and some countries - such as Hungary, Iceland and Ukraine - had to seek emergency assistance from the International Monetary Fund to restore their economies (International Monetary Fund 2010a, 2010b). A comprehensive review of the effects of the GFC on the global economy can be seen in a study by Shahrokhi (2011).

There is little consensus on the causes of the GFC. Claessens et al. (2010) show several causes - such as asset price bubbles and current account deficit - that are common to previous crises, and also identify new causes of the GFC - for example, increased international financial integration, and dependence on wholesale funding. Allen and Carletti (2010) suggest that two sources of the crisis were loose monetary policy and global imbalance. Notably, Jickling (cited in Shahrokhi (2011)) outlines a list of 25 causes of the crisis, including imprudent mortgage lending, a housing bubble, the failure of risk-management systems, excessive leverage and short-term incentives. Cheung, Fung and Tsai (2010) show that the crisis resulted in sharp declines of asset prices, caused serious liquidity problems for commercial banks and financial institutions, and lead to a fundamental change in the relationships among both advanced and emerging markets. An overview of the causes and consequences of the GFC is presented in the study by Allen and Carletti (2010).

1.2.2 Equity-market linkage

Equity-market linkage refers to an interaction among equity markets through which investors can optimise their risk-adjusted returns by diversifying their investment portfolios across markets. The concept is based on two foundational theories. The first is the purchasing power parity theory, which posits that relative prices of identical goods should be in equilibrium to represent their purchasing power across markets (Brooks 2002; Del Bianco 2008; Korap & Aslan 2010). The second is the modern portfolio theory, which states the important roles of risks, returns and correlations in constructing the investment portfolios of investors and

suggests that investors may get higher returns if they diversify internationally (Elton & Gruber 1997; Gkлезakou & Mylonakis 2010). Although both of these theories are based on a number of simplifying assumptions, they remain the cornerstones of modern finance in asset management.³

In the existing literature, equity-market linkages have been focused mainly on three types of linkages, namely co-integration, causality and contagion, depending on the nature of linkages. Co-integration and causality describe fundamental linkages among equity markets and are known as long-run and short-run linkages respectively. Contagion relates to the transmission mechanism of a shock among equity markets during periods of crisis by capturing a significant increase in correlations of market volatilities (Forbes & Rigobon 2002; Corsetti, Pericoli & Sbracia 2005).⁴ Together, these three linkages represent a comprehensive picture of cross-market linkages.

In early studies on global equity-market linkages, most researchers explain linkage sources with regard to fundamental linkages such as trade and finance links (Kearney 2000; Phylaktis & Ravazzolo 2002; Pretorius 2002; Khalid & Kawai 2003). However, in the 1990s as global markets experienced a series of crises, other sources of linkages - known as irrational linkages - emerged such as imperfect information, investor sentiment and multiple equilibrium (Dornbusch, Park & Claessens 2000; Karolyi 2003).⁵

Recently, several researchers have documented limitations of modern finance theories in the real world, particularly in a context of financial crises, as correlations of global equity markets appear to increase (Cheung, Fung & Tsai 2010; Chakrabarti 2011). Thus, an understanding of equity-market linkages during periods of crises is of interest to researchers and practitioners. Due to the severity and multiple effects of the GFC, a large number of studies examine the effects of the GFC on advanced and major emerging markets that have strong links with the US rather than small and young equity markets. The primary objective of this thesis is to explore the effects of the GFC on a small and young emerging market and on its linkages to global equity markets.

³See Chapter 2 for a more detailed discussion of these theories.

⁴In case volatilities of markets increase simultaneously during times of crisis, an interdependent linkage is suggested.

⁵Multiple equilibrium relates to changes in the expectations of investors that are subject to multiple equilibriums.

1.3 Research questions and methodology

1.3.1 Research questions

Known as a young market in the Southeast Asian region with impressive growth rates and regulations towards global integration, the Vietnamese equity market has attracted a large number of foreign investors in recent years. However, due to the severity of the GFC, the market experienced sharp declines in its performance over the period 2007–2008. Hence, the overall objective of this thesis is to investigate the impacts of the GFC on the Vietnamese equity market. The thesis addresses several research questions to clarify the research objective.

In the era of global market integration, the GFC originated in the US but spread across global markets at a significantly faster rate than previous crises. A number of studies demonstrate the severe effects and serious consequences of the GFC on equity markets around the globe (Claessens et al. 2010; Dabrowski 2010; Kurth 2011; Samarakoon 2011; Sen 2011). However, almost all empirical analyses examine the impacts of the GFC on advanced and major emerging markets that have close trade linkages with the US rather than young emerging markets like Vietnam. Therefore, the first question we raise in this thesis is to analyse the impacts of the GFC on the Vietnamese equity markets:

Question 1: To what extent has the GFC affected the Vietnamese stock market?

With globalisation has come relaxation in international capital movements and improvements in information technology, enabling foreign investors to diversify their investment portfolios internationally in order to improve their risk-adjusted returns. However, as global equity markets have become more integrated, particularly among advanced markets, investors are looking to emerging markets to diversify their investments. In recent years, the Vietnamese equity market has become recognised as an emerging market with a high development growth rate, and it has increasingly attracted the attention of foreign investors. However, due to this market being relatively young - just over 10 years of operation - research on Vietnamese equity-market linkages with global markets is sparse. Hence, another question examined by this thesis is whether equity-market linkages exist between and among the Vietnamese and global equity markets.

In the existing literature, two fundamental linkages among markets are often investigated: co-integration (representing a long-run relationship) and causality (referring to a short-run relationship). In this thesis, we examine both of these linkages in the relationships between and among the Vietnamese and global equity markets, resulting in the following two research questions:

Question 2: Does a co-integration relationship exist between and among the Vietnamese and other selected equity markets?

Question 3: Is there a causal relationship between and among the Vietnamese and other selected equity markets?

It is widely documented in the literature that equity-market linkages are dynamic and subject to change, especially during crisis periods (Bollerslev 1990; Engle 2002; Forbes & Rigobon 2002; Corsetti, Pericoli & Sbracia 2005). However, unlike previous crises, the GFC has more greatly affected global equity markets because of its severity and global reach. As a result, the GFC may cause unexpected changes in global market linkages. Therefore, another issue discussed in this thesis is whether the linkages between the Vietnamese and other selected markets have changed under the impacts of the GFC.

Question 4: Do the co-integration and causal relationships between Vietnam and other selected markets change over the GFC period?

An understanding of how the GFC transmitted to Vietnam and other markets is another concern of the thesis. Volatilities change significantly among the markets, especially in the context of the GFC; hence, when and how the GFC affects the global market is of interest to researchers. Previous studies investigate the propagations of shocks in the global equity markets; however, just a few studies examine young thin markets like Vietnam. This is addressed in the fifth and final research question:

Question 5: Did the GFC transmit a shock to the Vietnamese stock market and other selected markets? If yes, how and where did the shock originate?

1.3.2 Research methodology

To answer the research questions above, we employ several research models and techniques:

Firstly, the impacts of the GFC on the Vietnamese equity market are explored by identifying and analysing changes on market environment factors during the pre- and post-crisis periods. Several market-level factors, such as market regulations, market performance and the investor base, are taken into account. In addition, this thesis documents market-environment factors in the Vietnamese equity market that may influence cross-market linkages.

Second, a series of empirical models associated with the co-integration and causal relationships are used to investigate market linkages between and among the Vietnamese and global markets. These models can be classified into two groups of tests to address different types of linkages. The first group of models are co-integration tests that test for long-run co-movements between the Vietnamese and global markets. This group includes tests based on residuals, tests allowing for structural breaks and tests based on a vector autoregressive (VAR) model. The second group of tests is causality tests, which include pair-wise Granger and multivariate Granger causality tests. These are used to explore a short-run linkage between and among the impacts. In addition, further analyses based on the VAR model are performed to analyse the effects of a shock to one market on other markets as well as causal linkages among variances of the markets in the dynamic structure of equity markets.

Third, to examine the impacts of the GFC on both the co-integration and causality linkages of the Vietnamese and global markets, this thesis employs the pre- and post-analysis technique. Specifically, the period of study is separated into sub-periods, namely the pre-crisis, crisis and post-crisis periods, and empirical findings during the pre- and post-crisis periods are compared to examine the effects of the crisis. The pre- and post-crisis periods are determined based on the visual inspection of equity-market movements.

Finally, contagion tests using the multivariate autoregressive conditional heteroskedasticity (MGARCH) model are taken into account to explore the transmissions of the GFC to the Vietnamese and other markets. Both the constant and dynamic conditional correlation tests are conducted to investigate the time-varying correlations between any pairs of markets. The pre- and post-analysis techniques are also conducted in the tests.

Table 1.1 below provides a summary of the research models employed in the thesis.

Table 1.1: Research models in the thesis

Relationship	Research model	Empirical testing model
Co-integration (long-run linkage)	Co-integration tests	Bivariate co-integration tests based on residual Bivariate co-integration tests based on VAR model Bivariate co-integration tests allowing for structural breaks Multivariate co-integration tests based on VAR models
Causality (short-run linkage)	Causality tests	Pair-wise Granger causality Multivariate Granger causality based on VAR model VAR analysis (impulse response function and variance decomposition)
Contagion effect	MGARCH	Constant conditional correlation Dynamic conditional correlation

1.4 Scope and contributions

1.4.1 Scope

The impacts of the GFC on the Vietnamese equity market in this thesis are investigated using secondary data published by Vietnamese government authorities and reputable international organisations such as the World Bank, the International Monetary Fund and the World Federation of Exchange. However, due to lack of available data at the sectoral level, the thesis only examines the impacts of the GFC at the market-environment level.

To examine the linkages between the Vietnamese and global markets, we use equity-market indices of countries that have continuously maintained leading positions in the foreign direct investment (FDI) flows of Vietnam in recent years, including Hong Kong, Japan, Korea, Singapore, Taiwan, US, Malaysia and Thailand.⁶ Therefore, the study sample includes nine benchmark equity market indices: the VN-Index (Vietnam), the Hang Seng Index (Hong Kong), the TWSE Composite Index (Taiwan), the Strait Times Index (Singapore), the KSE Composite (Korea), the Nikkei 225 Stock Average (Japan), the S&P 500 Composite Index (US), the KLSE Composite Index (Malaysia), and the SET Index (Thailand).

The time series data was collected from DataStream, covering the period 28 July 2000–31 December 2010, and comprises 2721 observations for each series. The first day in the period

⁶The study sample is discussed in more detail in Chapter 4.

of study is selected because it was the first trading day in the Vietnamese equity market. This period of study covers the entire period of the GFC. For the purposes of investigating the effects of the GFC on market linkages, the period of study is divided into three sub-periods:

- the pre-crisis period 28/7/2000–31/8/2008, comprising 2111 observations for each series
- the crisis period 1/9/2008–28/2/2009, comprising 130 observations for each series
- the post-crisis period 1/3/2009–31/12/2010, comprising 480 observations for each series.

1.4.2 Contributions

With the research objectives and research questions discussed above, this thesis makes the following contributions:

Firstly, due to a relatively young market, existing research on the Vietnamese equity market is sparse. In particular, there is a lack of studies investigating the impacts of the GFC on the market as well as on its linkages to the global market. Therefore, the primary contribution of this thesis is to widen the existing body of literature by providing new empirical results on global equity-market linkages with regard to a young equity market.

Second, a large number of studies investigate propagations in global equity markets; however, only a few examine a young and thin market like Vietnam. Hence, the empirical findings of this thesis provide further empirical results on the transmission of a shock from the GFC to an emerging market.

Third, the empirical findings on the linkages between the Vietnamese and selected markets provide practical implications to policy makers, State-Bank officers and international portfolio managers. The results reveal the extent of linkages between Vietnamese and other markets, and provide information for policy-makers to take into account when monitoring international monetary policies and managing the market. State-Bank officers may also learn from the impacts of the GFC on the Vietnamese equity market, enhancing their supervisory and monitoring role in the future. International portfolio managers may learn from the market linkages between and among the markets to exploit the benefits of international portfolios that include these markets.

1.5 Organisation

This thesis is organised into six chapters as follows:

Chapter 1: Introduction

This chapter presents a broad overview of the thesis. It provides a summary of key issues in the literature as well as the research questions and methodology. The scope and contributions of the thesis are also discussed in the chapter.

Chapter 2: A review of financial crises and equity-market linkages

This chapter presents a systematic review of equity-market linkages, particularly in the context of crises. Firstly, it describes the background to financial crises, including definitions, and causes and consequences, with a particular focus on the GFC. Second, the chapter discusses definitions and foundational theories with regard to equity-market linkages to identify prominent themes that have emerged in the market-linkages literature. Reviews of empirical research on equity-market linkages in relation to these themes are given in more detail. Finally, the chapter provides an exclusive review of the impacts of financial crises on equity-market linkages with regard to both the empirical findings and the research methods used in the literature.

Chapter 3: The Vietnamese equity market: pre- and post-Global Financial Crisis

This chapter provides the background to the Vietnamese equity market and the impacts of the GFC on the market. The impacts are divided into three main categories relating to the market environment: market regulations, market development and investor base. The factors in the market environment influencing cross-market linkages between the Vietnamese and other markets are also discussed.

Chapter 4: Data collection and research methodology

This chapter consists of two parts. Firstly, it describes the data and sample used in the thesis, including period of study and data-processing techniques. A preliminary analysis of the data

is given. Second, the techniques used to conduct the empirical testing models are discussed and justifications for the selected models are given.

Chapter 5: Empirical estimations with models

This chapter provides the empirical results found in the thesis with regard to equity-market linkages between and among the Vietnamese and global markets by using co-integration, causality and contagion tests. In addition, the impacts of the GFC on the linkages are discussed based on a comparison of the findings during the pre-crisis and post-crisis periods.

Chapter 6: Conclusions and recommendations

This chapter presents the major findings of the thesis and further identifies implications for policy-makers, State-Bank officers and international fund managers. The chapter also indicates the limitations of the thesis and suggests research directions for future studies.

Chapter 2: Literature on Financial Crises and Equity-market Linkages

2.1 Overview

Derived from the research questions identified in Chapter 1 as to whether equity-market linkages exist between and among the Vietnamese and global markets, and whether the GFC affected these linkages, this chapter reviews the literature to identify common linkages among global equity markets and investigate whether these linkages change over periods of crises.

This chapter provides a systematic review of the background of definitions, foundational theories and related issues associated with equity-market linkages and the impacts of financial crises on equity-market linkages. The chapter includes six sections. Section 2.2 describes the background to financial crises including definitions, and causes and consequences of crises. Section 2.3 provides definitions of linkages in global equity markets and foundational theories of linkages. The sources of linkages are also given in order to identify the nature of these linkages. Section 2.4 discusses key issues that have emerged in previous studies on equity-market linkages as well as common methods used to test for the linkages. The effects of financial crises on equity-market linkages are presented in section 2.5. Section 2.6 concludes the chapter.

2.2 Background to financial crises

Over the last two decades, the global economy has experienced a series of financial crises. Examples include the 1994 peso collapse in Mexico, the 1997 financial crisis in Asia, the 1998 bond-market collapse in Russia, the 1999 Brazilian currency crisis and the 2007 subprime crisis in the US. A distinguishing feature of these crises is that they originated in a specific country and spread to neighbouring, regional and/or global markets. To provide a systematic review of financial crises, this section presents a brief discussion of definitions, causes and consequences of financial crises with a particular focus on the GFC.

2.2.1 Definition

The aforementioned financial crises originated from distinct areas such as the banking sector, currency markets, real-estate markets and bond markets. As a consequence, several definitions have emerged over time. In early studies, Friedman and Schwartz (1963) explain a financial crisis with a specific focus on banking panic. Derived from the monetary history of the US over the period 1867–1960, their definition posits that financial crises originate from a sharp decline in the money supply, leading to severe effects on economic activities. In other words, this definition links financial crises with banking panics. The definition is limited because it is based mainly on the monetarist's viewpoint (Mishkin 1992).

Seminal works on financial crises were provided by Kindleberger (1978) and Minsky (Minsky 1972, 1982), who discussed the nature of financial crises and the different patterns of how they occur. They provided an overview of financial crises in relation to sharp declines in asset prices, causing a series of disturbances in the aggregate economy. However, their studies are arguably too broad and do not provide a rigorous theory on what fundamentals constitute a financial crisis (Mishkin 1992; Rosser, Rosser and Gallegati 2012)

Another viewpoint is provided by Gertler (1988), who takes a broader view of financial crises with regard to asymmetric information and financial structure.⁷ Gertler argues that asymmetric information may lead to inefficiencies in financial markets and have significant effects on real economic activities. However, this definition does not provide a unified framework for a financial crisis because it cannot explain how government interventions might help when a crisis occurs.

More recently, Mishkin (1992, p.118) discusses the nature of financial crises based on the asymmetric information framework to provide a precise definition of a financial crisis as follows:

A financial crisis is a disruption to financial markets in which adverse selection and moral hazard problems become much worse, so that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities.

⁷Asymmetric information implies that information is not available equally to all parties in a market. It may result in two problems: adverse selection and moral hazard in each transaction.

This definition clearly states that the nature of a financial crisis leads to an inability of financial markets to allocate funds efficiently and thus drive aggregate economic activity away from an equilibrium position. Overall, we may conclude from this definition that the feature of a crisis is a sudden and sustainable change in a financial market and financial asset prices. This definition is widely accepted among studies including Hahn and Mishkin (2000), Kwack (2000) and Barrell and Davis (2008).

2.2.2 Causes and consequences

Experience shows that crises often originate from a shock in one particular market, and end up not only affecting the origin market, but also many parts of the global markets. Thus, what causes the crises and the nature of the consequences are of interest to many researchers (Allen and Gale 2004; Yang and Lim 2004; Marcal et al. 2011; Rosser, Rosser and Gallegati 2012).

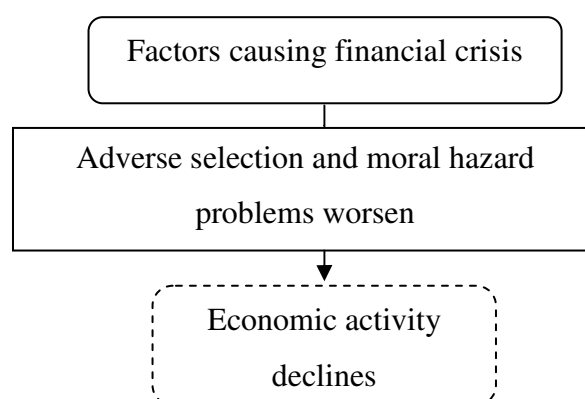
Different degrees of economic and institutional development in markets mean that causes of financial crises are often explained with regard to a specific crisis. For instance, while Dornbusch et al. (1995) indicate an increase in capital flows and a rigid exchange rate regime as two major causes of the 1994 Mexico crisis, Malliaris and Urrutia (1992) categorise the causes of the 1987 Russia crisis into macroeconomic and microeconomic weaknesses. Other studies by Timmer (2001) and Yang and Lim (2004) discuss several sources of the 1997 Asian financial crisis (AFC), including (1) a quasi-fixed exchange rate maintained by governments to minimise exchange-rate risks; (2) moral hazard problems in close relationships among government, banks, firms and individuals; and (3) financial panics as a result of herd behaviour by foreign investors carrying out massive capital withdrawals.

In a review of the anatomy of crises, Pasquariello (2008) indicates several sources of crises including macroeconomic and microeconomic weaknesses, monetary policy, coordination problems among investors, the activity of large traders and speculators, herding, and the interaction of stock and foreign exchange markets. Another study by Chan-Lau and Chen (1998) provides a brief review of four factors that can drive financial crises including fundamentals, expectations, multiple equilibria and moral hazard. The aforementioned studies all indicate that there is a range of factors that have the potential to be the source of a crisis.

One of the features of crises in recent decades is that many have originated in emerging countries. Thus, some researchers, such as Daly (2003) and Billio and Pelizzon (2003), explain sources of crises in relation to their underdeveloped financial markets, large deficit in reserve capital and weak governance. In addition, Timmer (2001) indicates that the recent crises in emerging markets have occurred due to the late transformations in their financial frameworks to meet the changes resulting from financial-market liberalisations.

From the arguments above, we may conclude that causes of financial crises include not only weaknesses in the fundamental factors of domestic financial markets, but also external factors. A sequence of financial crises is another issue that is of interest to many researchers. Mishkin (1992) provides the sequence of events in a typical financial crisis in the US, beginning with factors causing financial crises (for example, increases in interest rates, stock-market declines and increases in uncertainty), followed by adverse selection and increasing moral-hazard problems, leading to declines in aggregate economic activities (see Figure 2.1 below). This model is widely accepted and documented in many studies (Hahm & Mishkin 2000; Mishkin & Leeds 2006).

Figure 2.1: The sequence of events of a financial crisis



Source: Adapted from Mishkin (1992)

Based on Mishkin's model, Hahm and Mishkin (2000) develop a two-stage model to describe the propagation of a financial crisis including the run-up to a currency crisis, and from currency crisis to financial crisis. Specifically, they illustrate that the first stage of a financial crisis involves weaknesses in supervising and monitoring the banking system and financial markets in emerging countries. As a result, speculative attacks on a currency occur, causing the currency to depreciate and eventually to collapse. Financial and non-financial institutions are then confronted with adverse selection and moral-hazard problems, so they are not able to

channel funds effectively to the economy, leading to a potential collapse in economic activity. The model is widely used to describe the consequences of crises that originated in emerging-market countries rather than advanced-market countries. Another study by Barrell and Davis (2008) discusses the collapse of the asset structures during the GFC with regard to policy implications across countries. Due to its severity, the consequences of the GFC are still being discussed by researchers at the point of writing this thesis.

2.2.3 The Global Financial Crisis

The GFC is considered one of the most severe financial crises in the world so far. It has been compared to the Great Depression of the 1930s as a result of its severity and global reach (Kurth 2011; Sen 2011; Dwyer and Lothian 2012).

The onset of the GFC started in the US in 2006 as a result of the credit boom in the real-estate market, which in turn led to significant losses for banks and financial institutions that held mortgages and mortgage-backed securities. Specifically, the crisis can be traced to the low-interest-rate policy of the US government in the early 2000s, leading to dramatic increases in mortgage lending and house prices until 2005–2006. In early 2007, the speculative bubble of the US housing market erupted due to a massive credit expansion with regard to new financial instruments (that is, subprime loans, securitisation and derivative products), leading to the subprime mortgage crisis and the liquidity crunch in the global credit markets. This threatened the insolvency of global investment banks and other international institutions. The US equity market seemed to stabilise after the government announced a rescue plan for the global investment bank Bear Stearns in March 2008. However, the crisis intensified in September 2008 after the US Federal Reserve Bank and Government refused to rescue the giant investment bank Lehman Brothers, and announced the federal bailout of the major insurance corporation, AIG. These decisions caused panic reactions in both investors and financial institutions on a global scale, causing sharp declines in global market indices until the first quarter of 2009. A comprehensive historical review of the GFC can be found in the study by Arestis, Sobreira and Oreiro (2011) and Allen and Carletti (2010). In addition, Allen and Carletti (2010) show that the crisis was caused by the low-interest-rate policies adopted by the US government and the poor incentive of US financial institutions in risk assessments. A summary of major events during the crisis is shown in Appendix 2.1.

The GFC can be separated into several stages (Bartram and Bodnar 2009; Dooley and Hutchison 2009; Syllignakis and Kouretas 2011). For example, Dooley and Hutchison (2009) divide the crisis period February 2007–February 2009 into three phases. The first two phases (February 2007–April 2008 and May 2008–August 2008 respectively) reveal a sharp decline in credit markets in the US and Europe, while the third phase (September 2008–February 2009) shows a substantial decline in almost all markets across advanced and emerging countries. Dabrowski (2010) discusses the dramatic economic and social consequences for many regions and countries during the crisis by separating the crisis into two stages. He shows that the crisis spread quickly beyond the US to the developed countries in the first half of 2008, and then severely influenced emerging markets in the second half of 2008. Another study by Mishkin (2011) divides the GFC into two phases. The first phase (August 2007–August 2008) revealed limited effects and was generally known as the subprime crisis. The second phase (September 2008–early 2009) was severe. These studies imply that the severe period of the GFC was September 2008 to early 2009.

Much of the literature argues that the GFC was more severe than previous crises. Indeed, a study by Bartram and Bodnar (2009) shows evidence of a sharp decline in equity-market indices across regions, countries and sectors of approximately 40 per cent compared to their levels at the end of 2006 and around 60 per cent of their highest values, which is more severe than previous crises. Glezakou and Mylonakis (2010) indicate that while previous crises disturbed the financial systems in affected economies, the GFC penetrated many sectors of the global economy. Similarly, Guo, Chen and Huang (2011) demonstrate that the GFC penetrated a wide range of markets including stock, real-estate and energy markets as well as the credit default swap market, which was not affected in other crises.

Further, because it originated from an advanced market, the consequences of the GFC for the global market was more severe and unanticipated. Claessens et al. (2010) show that unlike previous crises, the GFC hit advanced markets first and emerging markets later. Berkmen et al. (2012) indicate that developed and emerging countries may suffer different effects from the crisis due to their differences in leveraged domestic financial systems, trade channels and exchange-rate policies. Cheung, Fung and Tsai (2010) suggest that the GFC may cause changes in the correlations among global equity markets for both emerging and developed markets.

2.3 Equity-market linkages

In the world economy, equity markets are becoming more integrated as a result of the liberalisation of trades, services and financial markets. This section provides information on equity-market linkages, starting with an overview of linkages followed by a discussion of theories and sources.

2.3.1 Overview of equity-market linkages

In recent decades, global equity markets have become more integrated due to a relaxation of restrictions on international trade, deregulation of financial policies and improvements in information technologies. Watson (cited by Kearney and Lucey (2004)) classifies international market integration into three stages: internationalisation, securitisation and liberalisation, depending on the penetration levels of foreign countries into host countries. Internationalisation and securitisation respectively describe the market development with regard to indirect and direct finance, while liberalisation refers to an abolishment of barriers on international trade, services and finance among countries.

In the existing literature, it is widely documented that there is a close relationship between market integration and market linkage (Johnson and Soenen 2002; Billio and Pelizzon 2003b; Aggarwal and Kyaw 2005). The underlying premise is that as equity markets become more integrated, their correlation will increase, leading to stronger linkages among the markets. However, empirical evidence shows that this viewpoint is not completely correct and that equity-market linkages may be more complex. For instance, examining co-integration among developing markets in the Asia-Pacific region, Ghosh, Saidi and Johnson (1999) find that some markets (Hong Kong, Indonesia, Korea and Malaysia) are dominated by the US markets while others (Singapore, Indonesia and the Philippines) are influenced by Japan, and still others (Taiwan and Thailand) are dominated by neither the US nor Japan. Another study, by Syriopoulos and Roumpis (2009), documents that in the medium and long run, the Balkan equity markets are influenced by the leading developed equity markets; however, in the short run, they are better explained by their neighbouring markets.

There are several types of linkages among equity markets and they can be classified into two main groups. The first group includes fundamental linkages among market levels and volatilities including co-integration (Huang, Yang and Hu 2000; Yin and Xu 2003; Aggarwal

and Kyaw 2005; Narayan and Smyth 2005; Sohel Azad 2009) and causality (Huang, Yang and Hu 2000; Sander and Kleimeier 2003; Yin and Xu 2003). The second group of linkages takes into account the impacts of a shock to one market on cross-market linkages during a turbulent period (Forbes and Rigobon 2002; Sander and Kleimeier 2003; Corsetti, Pericoli and Sbracia 2005; Dungey et al. 2005; Sohel Azad 2009; Yiu, Alex-Ho and Choi 2010). This group includes contagion and interdependence. As indicated by Forbes and Rigobon (2002), contagion refers to a significant increase in cross-market linkages after a shock while interdependence refers to a high degree of market linkages among all states of the world economy. In this thesis, we take into consideration the effects of the GFC on equity-market linkages, so we pay particular attention to the contagion effect rather than interdependence. In short, three common types of market linkages are discussed in this thesis: co-integration, causality and contagion.

2.3.1.1 Co-integration

The concept of co-integration was first introduced by Engle and Granger (1987), who discuss a long-run co-movement among variables. The authors suggest that if a combination of two non-stationary time series data is stationary, they are pair-wise co-integrated in the long run. In the context of equity-market linkages, co-integration implies that two equity markets may shift apart in the short run but they move together in the long run. The concept was later extended in a multiple time series context, known as a multivariate co-integration, by Johansen (1988) and Johansen and Juselius (1990).

Co-integration has been investigated in a wide range of relationships associated with various factors such as macroeconomic factors (Maki 2003; Narayan and Narayan 2010; Esteve, Navarro-Ibáñez and Prats 2013), commodity goods (Nanang 2000; Maslyuk and Smyth 2009; Subervie 2011), equity markets (Ahlgren and Antell 2002; Yu, Fung and Tam 2010), foreign-exchange markets (Tse and Ng 1997; Tai 2007; Kang 2008) and bond markets (Levy & Lerman 1988). Moreover, this concept has important implications for market efficiency and predictability (Moore and Copeland 1995; Caporale and Pittis 1998; Hassapis, Kalyvitis and Pittis 1999; Kellard 2006).

2.3.1.2 Causality

The causality concept was introduced by Granger (1969). Granger proposes that a causal relationship exists between two series if values of one variable can be better predicted by using past values of another variable. This is also known as a lead-lag relationship. An underlying assumption of the concept is that a current value of one variable can be measured by its own lagged values and lagged values of another variable. In early studies, researchers claim that the causal relationship is more applicable in the short run rather than the long run (Gupta 1987). However, when Granger (1988) extends the concept to a multivariate causality context and takes into account the existence of co-integration relationships, the concept can be applied to investigate both short-run and long-run linkages.

Causality has been investigated in various research areas such as macroeconomic factors (Huh 2002; Hsiao and Hsiao 2006; Wang, Yang and Li 2007; Chiou-Wei, Chen and Zhu 2008), commodity goods (Moosa and Silvapulle 2000; Yin and Xu 2003; Bekiros and Diks 2008) and equity markets (Malliaris and Urrutia 1992; Hue Hwa, Gan and Treepongkaruna 2004; Hong, Liu and Wang 2009). For example, Hsiao, Hsiao and Yamashita (2003)(2003)(2003) employ both pair-wise and multivariate Granger causality to test for linkages in terms of gross domestic product (GDP) growth rate and stock-price indices of the US and Asia-Pacific regions. They find no significant causal relationship in GDP growth rates, but strong unidirectional causality from the US to several stock-price indices in the region. Hong and Setaputra (2010) employ the multivariate Granger causality tests to explore the dynamic relationships among the US and five Association of Southeast Asian Nations (ASEAN) markets over the period 1992–2006. Their results show strong influences from the US to the ASEAN markets, but little effect from the ASEAN markets to the US over this period. In addition, the causal relationship indicates important implications in relation to predictability and causality (Eun and Shim 1989; Hsiao, Hsiao and Yamashita 2003; Cheung, Fung and Tsai 2010; Huyghebaert and Wang 2010).

2.3.1.3 Contagion

The term contagion was first used in chemistry with reference to a wide spread of medical diseases (Claessens & Forbes 2001). Since the late 1990s, when several countries observed sharp falls in their exchange rates as a result of the collapse of the Thai baht, this term has been widely used to describe international transmissions of a shock originating in one country

to other countries (Daly 2003; Candelon 2010). The literature on contagion includes a debate about definitions (Cuadro-Sáez, Fratzscher and Thimann 2009; Phylaktis and Lichuan 2009). While Daly (2003) and Forbes and Rigobon (2002) define contagion as a significant increase in the correlation between equity markets during a crisis; Dornbusch, Park and Claessens (2000) use the term to describe an increase in a cross-market linkage after a shock in one country, rather than only a strong linkage between countries. A comprehensive review of financial contagion can be found in the study by Pericoli and Sbracia (2003), who present five definitions of contagion and explain them in different contexts.

Among discussions on contagion, three definitions proposed by the World Bank are commonly used by scholarly researchers. The World Bank distinguishes between three levels of contagion (Claessens & Forbes 2001; Billio & Pelizzon 2003). The first definition is very broad, defining contagion as a cross-country transmission of shocks or cross-country spillover effects. This definition does not take into consideration the transmission of shocks in a crisis period. The second definition is more restrictive, stating that contagion is the transmission or co-movement of shocks in excess of what can be explained by economic fundamentals. As argued by Claessens and Forbes (2001), it provides indicators of vulnerability in the entire economy during a crisis. The third definition, which is very restrictive, emphasises a mechanism of shocks among countries in a crisis period. It is similar to a definition of ‘shift contagion’ by Forbes and Rigobon (2002). Among studies on contagion associated with crises, researchers often refer to the second and third definitions (Kuper and Lestano 2007; Gupta and Donleavy 2009; Yiu, Alex-Ho and Choi 2010; Yu, Fung and Tam 2010). Given that this thesis focuses on examining the effects of the GFC on equity markets rather than the entire economy, we will employ the third definition of contagion.

2.3.2 Theory of equity-market linkages

From the literature, international equity-market linkages are based on two theories: purchasing power parity theory (PPP) and modern portfolio theory (MPT). Details of these theories are discussed in this section

2.3.2.1 Purchasing power parity

Purchasing power parity (PPP) is one of the oldest theories in finance. According to Karim (2011), the theory evolved from studies by the School of Salamanca in Spain in the sixteenth

century and was reinforced by Guvtav Cassel in a series of works he conducted in the 1920s. The theory posits that relative prices of all identical goods should adjust in equilibrium to represent their purchasing power. Many researchers indicate that the theory is based on the law of one price, stating that prices of identical goods should be equalised if they are quoted in the same currency of denomination (Del Bianco 2008; Korap and Aslan 2010). The assumptions that underpin the theory are (1) identical goods in different markets; (2) no transaction costs; and (3) unrestricted international capital flow in international markets. Thus, several studies - for example, Brooks (2002) and Kearney and Lucey (2004), indicate that assets with identical cash flows could lead to the same rate of returns across countries.

After the collapse of the Bretton Woods system in 1973, PPP attracted increasing concern among researchers, who questioned the theory's underlying assumptions. For instance, Del Bianco (2008) discusses four problems associated with the assumptions: (1) traded goods in national and foreign markets are not completely identical; (2) tariff and non-tariff barriers are different among countries; (3) the existence of transaction costs; and (4) perfectly competitive markets are absent. Therefore, Del Bianco indicates that PPP may not be applicable in the short run but valid in the long run. Similar viewpoints are expressed by De Roos (1981), Hassanain (2004) and Korap and Aslan (2010).

Purchasing power parity is important in market linkages as it suggests, implicitly or explicitly, that a long-run relationship existed among markets. As indicated by Kearney and Lucey (2004), PPP theory implies equalisation of rates of return across countries. Many previous studies test for the existence of PPP theory in various market settings such as interest-rate markets (Khalid and Kawai 2003; Cuestas and Harrison 2010), bond markets (Sander & Kleimeier 2003) and exchange-rate markets (Taylor 1988; Tse and Ng 1997; Korap and Aslan 2010). A study by Taylor (1988) indicates that co-integration tests are often used to test for PPP theory as a long-run equilibrium across markets; as such, several studies examine the theory in equity markets, such as Johnson and Soenen (2002) and Lucey and Voronkova (2008).

2.3.2.2 Modern portfolio theory

Modern portfolio theory (MPT) was developed by Markowitz (1952), who argues that investors' attitudes in constructing their investment portfolios are exclusively based on the expected returns and risk of risky assets. The author claims that a correlation between two

assets returns is important in determining the level of risk of the portfolio, and that market risk can be reduced by incorporating weakly correlated assets into an investment portfolio (Elton and Gruber 1997; Glezakou and Mylonakis 2010; Vaclavik and Jablonsky 2012). Modern portfolio theory is based on several assumptions: (1) assets returns are normally distributed; (2) correlation is constant over time; (3) all investors have the same information at the same time; (4) investors are rational and price-takers; (5) financial instruments are homogeneous in portfolios; and (6) investors can enter both long and short positions (Resnik 2010; Vaclavik and Jablonsky 2012).

Based on the Markowitz risk-return definition, later studies made significant contributions to the development of the theory. For example, Sharpe (1964) states that the expected return and risk of a risky asset are not only based on its internal sources but on external or market sources as well. Sharpe considers market returns and variances the essential elements for determining the expected future returns. Another study by Solnik (1974) extends the theory to an international context and suggests that investors may get higher returns if they diversify internationally. Other studies, including those by Treynor and Mazuy (1965) and Jensen (1969), propose useful ratios to evaluate portfolio selection. A comprehensive review of the historical development and current state of the theory can be seen in Elton and Gruber (1997).

Since its publication, MPT has become a cornerstone of modern finance in asset management. Many studies find evidence supporting the theory (Sharpe 1963; Lintner 1965; Sharpe 1967; Kalyman 1971). Studies by Narayan and Smyth (2005) and Chen, Firth and Rui (2002) show that international portfolio diversification may reduce risk and enhance opportunities to earn high returns for investors. As such, investors should diversify their investment portfolio by investing in assets across countries that are less perfectly correlated. In contrast, Glezakou and Mylonakis (2010) confirm that investors cannot reduce systematic risks within a national economic context; thus, they decide to invest internationally.

However, recent studies show that crises lead to sharp declines in values of investment portfolios and portfolio diversification is not appropriate because all financial assets in the global markets decline (Resnik 2010; Miccolis and Goodman 2012; Vaclavik and Jablonsky 2012). Some researchers highlight the underlying assumptions of the theory. For example, Vaclavik and Jablonsky (2012) discuss four assumptions that are often not appropriate, particularly in a period of crisis. Firstly, the distribution of asset returns is log-normal rather than normal. Second, correlations of returns are not always constant in the context of market

turbulence. Third, assets with different characteristics can be combined into a portfolio. Finally, investors can also enter a short position in their investment portfolios. Another study by Resnik (2010) also indicates a limitation in the definition of an asset's risk as too narrow for the real world. Consequently, other theories associated with behavioural finance are of increasing interest to researchers.

In the context of the globalization of international financial markets, investors commonly invest globally in order to seek the best available returns. Thus, the rates of returns across assets and countries tend to equalize in order to satisfy the law of one price that is underlined by PPP theory. As a result, equity market returns across economies are likely to be co-integrated in the long-run. MPT additionally assumes that investors will diversify their investment portfolios by holding assets from different markets in order to maximize their future incomes. Their investment portfolios adjust periodically depending on expected returns as well as correlations among markets. Although these two theories [PPP and MPT] are commonly used in international asset management, limitations associated with them - for example, restrictions on cross-border investment, asymmetric information and irrational behaviours of investors - constrain their application in the real world. Therefore, the question of how to diversify investment portfolios internationally is an ongoing concern of investors and researchers, particular in the context of crises.

2.3.3 Sources of equity-market linkages

In the existing literature, many studies discuss sources of equity-market linkages. In early studies, several researchers discuss the driving forces behind equity-market linkages and indicate several sources, such as international trades and financial linkages (Phylaktis and Ravazzolo 2002; Khalid and Kawai 2003) and economic fundamentals linkages (Kearney 2000; Pretorius 2002). For example, Pretorius (2002) shows that bilateral trade, industrial product growth and region are significant factors explaining the linkages among 10 emerging stock markets over the period 1995–2000. However, the author also indicates that these factors only explain 40 per cent of the market linkages. Therefore, he claims that there may be different factors driving the integration among markets.

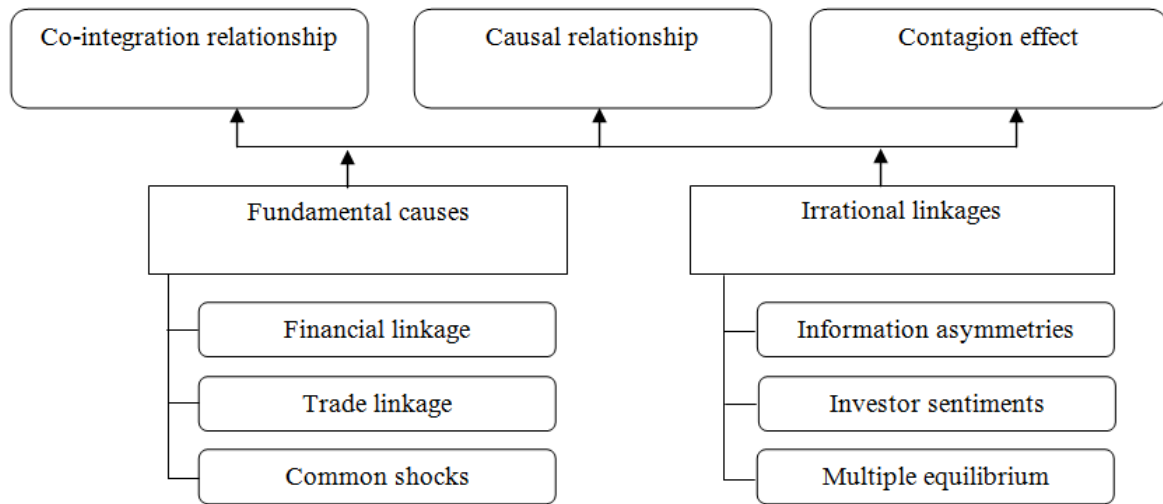
In the decade of the 1990s, global equity markets experienced a series of crises that originated in different parts of the world and were transmitted to regional and global markets. Thus, several researchers argued that economic fundamentals do not seem to provide a thoughtful

explanation of global market linkages (Masson 1999; Khalid and Kawai 2003; Dungey and Tambakis 2005). This raises concerns about the transmission mechanism of contagion. Masson (1999), for instance, discusses three sources of contagion: monsoonal (or a common shock), spillover and pure contagion. In contrast, Khalid and Kawai (2003) document three different sources of contagion: common shocks, financial linkages and shifts in investor sentiments. Pericoli and Sbracia (2003) propose sources of contagion with regard to interdependence, initial shock, fundamental channel of transmission and international transmission of panic.

A survey on financial contagion is found in the study by Dornbusch, Park and Claessens (2000) wherein the authors discuss a significant increase in cross-market linkages among markets after a shock in comparison to a tranquil period. Specifically, they discuss two sources of contagion over turbulent periods. The first source, referred to as the ‘fundamentals-based channel’, emphasizes co-movements in financial asset prices resulting from real and financial linkages. It may be caused by a global or local shock and then transmitted across borders through trade or finance linkages. The second source is not linked to macroeconomic or fundamental factors but is attributed to investor behaviour. Specifically, contagion is transmitted when investors adjust their investment portfolio to share macroeconomic risk factors among countries even if the countries are absent of real and financial linkages. A similar viewpoint is proposed by Karolyi (2003) and Caramazza, Ricci and Salgado (2004). Based on these studies, it may be concluded that the sources of contagion derive not only from fundamental factors but also from investors’ behaviour.

A summary of the relationship between common sources of linkages and types of linkages is given in Figure 2.2 below.

Figure 2.2: Equity-market linkages



2.4 A review of equity-market linkages

As discussed above, equity-market linkages can be classified into three groups according to their relationships. This section reviews emerging issues regarding these relationships.

2.4.1 Co-integration

Empirical studies of co-integration have been extensive and inclusive (Huang, Yang and Hu 2000; Daly 2003; Lucey and Voronkova 2008; Cheung, Fung and Tsai 2010; Huyghebaert and Wang 2010). These studies can be classified into several groups with regard to considered markets, including advanced markets, emerging markets and mixed markets. A study by Syllignakis and Kouretas (2011) indicates that recent studies have focused on the linkages between advanced and emerging markets. In addition, empirical findings on co-integration among equity markets vary over time, depending on the markets examined, the period of study and the research methods (Fernández-Serrano and Sosvilla-Rivero 2001; Gupta and Guidi 2012).

The markets examined in studies on equity market linkages are commonly chosen based on market linkages including trade and foreign direct investment. For instance, Ghosh, Saidi and Johnson (1999) investigate the co-integration between both the US and Japan and the Asian Pacific markets including Hong Kong, India, Taiwan, Korea, Malaysia, Singapore, Philippine and Thailand because the two countries [US and Japan] are major investors, trading partners

and have an influence on the regional markets. Similarly, Daly (2003) selects the Southeast Asian markets to examine equity market linkages due to the rapid integration of trade and capital markets between the economies in the region. Lucey and Voronkova (2008) likewise examine the linkages between the Russia and Central and Eastern European equity markets because Russia is known as an important trading partner of the countries and a major direct investment partner in the region.

A study by Ghosh, Saidi and Johnson (1999) examines a long-run relationship between two developed markets, the US and Japan, and the Asia-Pacific markets. Their results show that while a long-run relationship exists between both the US and Japan and several markets in the region, Thailand and Taiwan do not co-move with either of the other markets. The authors argue that the different results are due to the different linkages of macroeconomic factors of these countries.

Lucey and Voronkova (2008) investigate co-integration relationships between Russian and global equity markets over the period 1995–2004. They do not find strong linkages in the long-run relationship between the Russian and either regional or developed markets, and conclude that the Russian equity market was isolated from international markets during the examined period.

A study by Aloui, Aïssa and Nguyen (2011) shows that recent literature on equity market co-movement has become an increasing area of study for many researchers as a result of the globalisation of capital markets around the world. They argue that many studies find evidence of greater co-integration in recent periods as a result of the liberalisation and globalisation of equity markets. In addition, many studies reveal that long-run relationships among global equity markets may vary over time (Cheung, Fung and Tsai 2010; Huyghebaert and Wang 2010). This variation may be explained by the differences in liberalisations of finance and banking system as well as the abolishment of barrier sets in trade and services among countries, particularly emerging countries. However, other studies show that co-integration relationships vary over time (Ghosh, Saidi and Johnson 1999; Lucey and Voronkova 2008; Cheung, Fung and Tsai 2010).

Various testing models can be applied to examine the co-integration relationship. A study by Glezakou and Mylonakis (2010) describes the development of co-integration tests from a regression analysis model (Agmon 1972) to co-integration tests based on VAR model (Engle

& Granger 1987). Three co-integration tests commonly used are those based on residuals, those based on VAR models and those allowing for structural breaks. Some researchers find that the results of these tests are somewhat inconsistent, and they explain mixed results partly by differences in periods of study, frequency of data and research methods employed (Fernández-Serrano and Sosvilla-Rivero 2001; Gupta and Guidi 2012).

2.4.2 Causality

Since they were introduced by Granger (1969), causal relationships between markets have received increasing interest among scholarly researchers (Huang, Yang and Hu 2000; Chen, Firth and Rui 2002; Khalid and Kawai 2003; Sohel Azad 2009; Cheung, Fung and Tsai 2010; Glezakou and Mylonakis 2010; Huyghebaert and Wang 2010). Studies on causality can be grouped into three strands with regard to research markets; developed markets (Glezakou and Mylonakis 2010), emerging markets (Chen, Firth & Rui 2002) and mixed markets (Huang, Yang and Hu 2000; Khalid and Kawai 2003; Glezakou and Mylonakis 2010; Huyghebaert and Wang 2010). Khalid and Kawai (2003) investigate causal relationships among three different markets - foreign-exchange, stock and interest-rate markets - of nine East Asian countries and find some evidence on causality among and across markets in the region. However, the results do not strongly support causal linkages among the stock markets.

There are two common testing models associated with causality. The first model is a pair-wise Granger causality proposed by Granger (1969), while the second is a multivariate Granger causality suggested by Engle and Granger (1987). Both models are widely used in studies (Huang, Yang and Hu 2000; Sander and Kleimeier 2003; Yin and Xu 2003; Au Yong, Gan and Treepongkaruna 2004). Huang, Yang and Hu (2000), for instance, use pair-wise Granger causality to examine the causal relationships among stock markets of the US, Japan and the South China Growth Triangle (SCGT) region over the period 2 October 1992–30 July 1997. They find that the US market has more effects on the SCGT markets than Japan, and a significant bi-directional relationship existed between the Shenzhen and Shanghai stock exchange. Another study by Hsiao, Hsiao and Yamashita (2003), using both the pair-wise and multivariate causality tests, finds evidence of a mono-directional relationship from the US to Japan, Korea and Taiwan but not China over the period September 2001–December 2002. In addition, two further tests, known as VAR analyses, are often used to obtain insights into the interdependence structure among equity markets. The first test is an impulse response function used to trace impacts of innovation in a particular market to each of other markets

while the other is a variance decomposition to measure the relative importance of variances of each market to generate expected variances of a particular market. Empirical findings based on the VAR analyses are generally supported for further understandings of causal linkages among examined markets (Eun and Shim 1989; Hsiao, Hsiao and Yamashita 2003; Yang and Lim 2004).

2.4.3 Contagion

As previously discussed, contagion is a relatively new concept in comparison to co-integration and causality; however, it has attracted many researchers, particularly in the context of crises in recent years. Studies on contagion are examined for different levels, such as cross nations (Khalid and Kawai 2003; Yin and Xu 2003; Au Yong, Gan and Treepongkaruna 2004; Cheung, Fung and Tsai 2010), cross markets (Khalid & Kawai 2003), cross industries (Phylaktis and Lichuan 2009; Wang 2010) and cross products (Arshad & Hameed 2009). Phylaktis and Lichuan (2009) examine contagion in a sectoral perspective among global equity markets in Europe, Asia and Latin America over the period 1990–2004. The authors find a distinct pattern in sector-level contagion across regions, but note that it varies across regions. Interestingly, the results demonstrate that the financial sector does not exhibit contagion effects with respect to the US in Europe and Asia but does in Latin America.

Since there are several definitions of contagion discussed above, empirical testing models of contagion vary widely. Pericoli and Sbracia (2003) show two groups of tests: the first group focuses on measuring the transmission of a shock from one country to another country and the second group tests on structural breaks in correlation. In the meantime, Ahlgren and Antell (2010) follow a co-breaking analysis based on the VAR model to test for contagion.⁸ A review of contagion models can be seen in Dungey et al. (2005), who discuss various empirical testing models, such as correlation and variance (Forbes & Rigobon 2002), the factor model (Bekaert, Harvey & Ng 2005; Corsetti, Pericoli & Sbracia 2005), the VAR approach (Favero & Giavazzi 2002) and dynamic conditional correlation (Engle 2002).

⁸If variables have a break in their conditional means but their linear combinations do not have the break, they are said to be co-breaking.

With regard to the third definition of contagion, taking into account the transmission mechanism of a shock among equity markets, Corsetti, Pericoli and Sbracia (2005) indicate that many studies suggest that the correlation between two market returns increases during periods of crisis. Similarly, Chiang, Jeon and Li (2007) indicate that the correlation of market returns is commonly used to investigate evidence of contagion. However, recent studies show that correlations are not static but vary over time; thus, several empirical models providing dynamic evolutions of the correlation matrix have been developed - for example, adjusted correlation (Forbes & Rigobon 2002), constant conditional correlation (Bollerslev 1990) and dynamic conditional correlation (Engle 2002). Among these models, the last two employ the MGARCH method, which is the most common method used in modelling market volatilities. In this thesis, we employ the constant conditional correlation (CCC) suggested by Bollerslev (1990) and the dynamic conditional correlation (DCC) developed by Engle (2002) to investigate the contagion effect.

2.5 Impacts of financial crises on equity-market linkages

The globalisation of financial markets has had effects on the risk management and portfolio diversification of investors. In addition, global equity-market linkages have altered unexpectedly as a result of recent financial crises.

2.5.1 Co-integration

The impacts of crises on equity-market linkages are discussed in a number of studies. In general, the studies can be classified into several groups according to the crisis under study - for example, the 1997 AFC (Chan Leong and Felmingham 2003; Daly 2003; Huyghebaert and Wang 2010), the 1998 Russian financial crisis (Lucey & Voronkova 2008) and the 2007 GFC (Cheung, Fung & Tsai 2010). Despite substantial studies documenting strong impacts of these crises on linkages (see for example, Cheung, Fung and Tsai 2010; Huyghebaert and Wang 2010), a few studies find insignificant effects (Kenourgios & Padhi 2012). For example, Cheung, Fung and Tsai (2010) indicate a stronger co-movement from the US market to the Hong Kong, Japan, China, Australia and Russia markets during the GFC, while Kenourgios and padhi (2012) document no co-integration between Argentina and the considered markets during the Argentina crisis of 1999–2000. Therefore, it may be concluded that different crises may exhibit different impacts on long-run relationships in the global equity markets.

When addressing long-run relationships between global equity markets during times of crises, two research approaches are commonly used. The first approach takes into account co-integration by separating data sets into a pre- and post-crisis period, followed by a comparison of the results of the two sub-periods. For instance, by employing bivariate and multivariate co-integration tests during the pre-crisis and post-crisis periods, Daly (2003) analyses market linkages among Indonesia, Malaysia, the Philippines, Singapore, Thailand, Australia, Germany and the US over the period 1990–2001. The empirical findings suggest no significant increase in co-integration between the Southeast Asian stock markets during the post-crisis period. The second approach investigates the relationship with an assumption of structural breaks in time series data sets resulting from the impacts of crises (Chan Leong and Felmingham 2003; Sohel Azad 2009; Huyghebaert and Wang 2010; Gupta and Guidi 2012). For example, Azad (2009) considers structural breaks in co-integration and finds evidence of a long-term relationship among the China, Japan and South Korea markets. Another study by Huang, Yang and Hu (2000) employs the Gregory and Hansen (1996) model to investigate co-integration with an emphasis on structural breaks caused by the AFC and finds no supporting evidence of co-integrating relationships among the SCGT (including the Hong Kong, Shanghai, Taiwan and Shenzhen markets), despite their intensified intra-regional trades.

2.5.2 Causality

Causal relationships are crucial for risk management and portfolio diversification of investors because they reflect interaction and interdependence among equity markets. As such, when crises occurred, a number of studies are conducted to explore whether causal relationships change among global equity markets during times of crises (Cheung, Fung & Tsai 2010; Gklezakou & Mylonakis 2010). In almost all of these studies, the pre- and post-analysis technique is employed to examine the impacts of a crisis on causal relationships (Malliaris and Urrutia 1992; Cheung, Fung and Tsai 2010; Huyghebaert and Wang 2010). In addition, several studies investigate impacts of crises on causal relationships based on the impulse response function and variance decomposition (see Yang and Lim (2004) Chuang, Lu and Tswei (2007)) to explore the shock or influence of one market on other endogenous markets in a dynamic structure.

In the literature, many empirical findings support a significant increase in causality among markets during crises. For example, Cheung, Fung and Tsai (2010) examine the interrelationship between the US market with respect to the UK, Hong Kong, Japan, Australia, Russia and China markets for the period 3 January 2003–3 April 2009. Their findings document the increasing influence of the US on the UK, Hong Kong, Japan, Australia, Russia and China during the 2007–2009 GFC. Likewise, Glezakou and Mylonakis (2010) indicate evidence in favour of dominant influences of the US equity market towards other developed markets during the GFC.

However, some studies show fewer effects of crises on the causal relationships among markets (Malliaris and Urrutia 1992; Chan Leong and Felmingham 2003). For example, Malliaris and Urrutia (1992) investigate the relationship for six major stock markets including the US, Japan, Hong Kong, London, Singapore and Australia and find no lead-lag relationship during the pre- and post-October 1987 crisis, but some directional relationships during the month of the crisis. In contrast, Dooley and Hutchison (2009) find no predictability in the US equity prices to the Mexican equity prices during the first and second phase of the GFC. However, during the third phase, the US market becomes a significant predictor of the Mexican market.

2.5.3 Contagion

Among studies on contagion in global equity markets, some studies examine the relationship in one crisis (Naoui, Liouane and Brahim 2010; Wang 2011; Gupta and Guidi 2012), while others take into consideration several crises (Forbes and Rigobon 2002; Dungey et al. 2007; Kenourgios, Samitas and Paltalidis 2011). However, although there are several models testing for contagion, empirical findings are somehow inconsistent. Using unconditional correlation coefficient tests, Forbes and Rigobon (2002) examine contagion effects in a wide range of markets during three recent crises: the 1997 East Asian crisis, the 1994 Mexico crisis and the 1987 US stock-market crisis. The results show interdependence among markets instead of contagion. However, using a single-factor model, Corsetti et al. (2005) show some contagion and some interdependence among examined markets during crises. Yiu, Alex-Ho and Choi (2010) examine the dynamics of correlations between 11 Asian stock markets and the US stock market, and find evidence of contagion between the US and individual markets in Asia from late 2007, but no such evidence is found during the AFC. A difference among empirical

findings on contagion is often explained by a difference of research methods associated with different definitions of contagion.

Overall, the empirical findings in the literature document mixed and inconclusive results on the impacts of crises on equity-market linkages. In addition, these linkages change differently depending on the examined crises, periods of study and research methods.

2.6 Chapter conclusion

Financial crises can originate in a specific country and then transmit to regional and global markets. As such, consequences of financial crises can be severe and unanticipated. Previous studies show that financial crises affect not only individual equity markets but also market linkages among global equity markets - for example, co-integration relationships (long-run linkages), causal relationships (short-run linkages) and the contagion effect (transmission of a shock caused by crises among markets). A series of empirical models and research approaches are suggested to examine equity-market linkages as well as the effects of crises on equity-market linkages among markets, such as co-integration tests, causality tests and contagion tests.

Unlike previous crises in terms of its origin and severity, the GFC had serious effects on the global economy. A systematic review of equity-market linkages and relevant empirical models discussed in this chapter sheds light for research methods as well as discussions of empirical findings in chapters 4 and 5 of this thesis respectively.

Chapter 3: The Vietnamese Equity Market: Pre- and Post-Global Financial Crisis

3.1 Overview

Although known as a young market, the Vietnamese equity market has achieved significant progress in terms of market capitalisation, the number of listed companies and the investor base over 10-years of operation. Market regulations have gradually moved towards transparency, equality and integration. However, compared to other equity markets in the Asian region and around the globe, the Vietnamese equity market is still relatively small in terms of market capitalisation and size.

Following the economic downturn of the global economy caused by the GFC, the Vietnamese equity market experienced severe effects on both market size and performance during the 2007–2008 period. This raises the question of how the environment of the Vietnamese equity market changed as a result of the GFC, and to what extent the market environment affected market performance and cross-market linkages.

To answer these questions, this chapter examines changes in market environment such as regulation, performance, listing activity and investor base, and then identifies critical factors in the market environment that influence its linkages in the global market. The pre- and post-crisis analysis technique is used to investigate the effects of the GFC in the market. To determine the pre- and post-crisis period, we visually inspect the movement of the Vietnam aggregate market index and identify breaks in its movement. Specifically, the pre-crisis period is from the first trading day of the market (28/7/2000) to 30/8/2008. The crisis period is from 1/9/2008 to 28/02/2009. The post-crisis period is from 01/03/2009 to 31/12/2010. Our crisis periods are consistent with descriptions and analyses in the studies by Dooley and Hutchison (2009) and Mishkin (2011).⁹

The structure of the chapter is as follows. Section 3.2 provides a background to the Vietnamese equity market. The historic performance of the Vietnamese equity market is

⁹See section 4.2.1(Data processing) in Chapter 4 of this thesis for further discussion.

discussed in section 3.3. Section 3.4 discusses the market's investor base. The market environment influencing equity-market linkages is discussed in section 3.5. Section 3.6 concludes the chapter.

3.2 Background to the Vietnamese equity market

3.2.1 History

Since the late 1980s, following the 'Doi Moi' (translated as 'Renovation') program of economic reform, the Vietnamese economy has transformed from a centrally planned to a market-oriented economy. As a result, the economy has achieved significant results during this development process (see Appendix 3.1).

With regards to its financial market development, Vietnam has reformed its banking system by adding more financial institutions and through the launch of stock exchanges (Farber, Nam & Hoang 2006). On 6 November 1993, the Government issued Decision No. 207/QĐ-TCCB with the purpose of setting up a research and development team belonging to the governor of the State Bank. Later, in September 1994, the government issued Decision No. 361/QĐ-TTg to set up a board to prepare for the establishment of the stock market. The board had the following responsibilities:

- preparing legal regulations on securities and the securities market;
- preparing legal documents on the establishment of the State Securities Commission of Vietnam (SSC);
- preparing relevant equipment and human resources for government and market management as well as for traders in the market; and
- co-operating with other stock markets and international organisations in managing the Vietnamese securities market.

Established in November 1996, the SSC is in charge of the organisation, development and supervision of the securities market. Initially, the organisation operated under the responsibility of the prime minister. However, since February 2004, it has worked under the management of the Ministry of Finance.

The SSC manages four key organisations in the market. The first is the Ho Chi Minh Stock Trading Center, established on 28 July 2000 and renamed the Ho Chi Minh Stock Exchange

(HOSE) on 8 August 2008. The second is the Ha Noi Stock Trading Center, launched on 8 March 2005 and renamed the Ha Noi Stock Exchange on 24 June 2009. The other two organisations are the Center for Securities Research and Training, established in December 1997, and the Vietnam Securities Depository, established in May 2006. It is notable that the HOSE, rather than the Ha Noi Stock Exchange, is often cited as the main exchange in Vietnam because of its higher market-capitalisation scale and longer history. The aggregated stock-market index of the HOSE, the VN-Index, is often considered the benchmark index for Vietnam. This index is commonly used in a range of studies in the literature (Ha 2007; Kallinterakis 2009; Loc, Lanjouw and Lensink 2010; My and Truong 2011). Hence, in this thesis, information on the Vietnamese equity market refers to the HOSE. The development timeline of the Vietnamese equity market is summarised in Table 3.1 below.

Table 3.1: Development timeline of the Vietnamese equity market

Year	Development of the market organisation
1993	Research and development team established (November)
1994	Board for preparation of stock-market establishment set up (September)
1996	States Securities Commission established (November)
1997	Center for Securities Research and Training established (December)
2000	Ho Chi Minh Stock Trading Center launched (July)
2005	Ha Noi Stock Trading Center launched (March)
2006	Vietnam Securities Depository established (May)
2007	Ho Chi Minh Stock Trading Center renamed Ho Chi Minh Stock Exchange (August)
2009	Ha Noi Stock Trading Center renamed Ha Noi Stock Exchange (June)
2009	Unlisted Public Company Market (Upcom) belonging to the Ha Noi Stock Exchange established (June)

3.2.2 Regulations

Regulations in the Vietnamese equity market are promulgated by the government and the management board of stock exchanges. Regulation and related management issues are discussed in this section.

After 10 years of operation, regulations in the Vietnamese equity market have gradually moved towards global integration. However, there have been significant changes in the market regulations over the pre-crisis, crisis and post-crisis periods.

During the early years of the pre-crisis period, the Vietnamese equity market was known as a ‘pilot market’ and was subject to adjustments and strict regulations, particularly trading regulations such as trading hours, trading units and price-limit regulations. The most powerful regulation was Decree No. 48/1998/ND-CP, issued on 11 July 1998, followed by Decree No.

144/2003/ND-CP, issued by the government on 28 November 2003. These two documents cover fundamental articles in relation to initial public offerings, listing activity, securities trading and supervision of securities market - for example, responsibilities and rights of the stock trading centre; main businesses of securities companies; qualifications for listed companies and listed procedures for equitised companies.

The market authorities also issue a range of trading regulations such as listing requirements, trading mechanisms and trading information disclosure in the stock exchanges. For example, the trading hours span from 08:30 to 10:30 from Monday to Friday. There are three types of trading orders used in the market: a limit order, an at-the-opening order (ATO) and an at-the-closing order (ATC). In addition, the price-limit regulations are strictly controlled by the government and span from ± 2 per cent to ± 7 per cent. A review of the trading regulations can be seen in the studies by Farber, Nam and Hoang (2006) and Loc, Lanjouw and Lensink (2010). In addition, Farber, Nam and Hoang (2006) indicate that regulation of market information in the Vietnamese equity market is rather weak because less information is disclosed in the market.

During the period 2006–2007, regulations in the market moved towards global integration. The 2007 Securities Law was first passed by the National Assembly of Vietnam on 29 June 2006 and officially enacted on 1 January 2007. The law regulates issues in relation to securities markets, securities services, public offerings, and listing and trading in securities. Later, on 17 January 2007, the government issued Decree No. 14 with regard to the regulation of securities companies, fund-management companies and securities-investment companies. Several articles in the regulations have been gradually removed to conform with Vietnam's international commitments towards global integration, such as a limited proportion of foreign investors' ownerships of listed firms, procedure to establish foreign-owned fund management companies, and cross-listing in stock exchanges.

In addition, the securities authority also issues regulations for strengthening the markets, such as Decision No. 12/2007/QĐ-BTC on 13 March 2007 on corporate management rules for listed companies and Circulation No. 17/2007/TT-BTC on 13 March 2007 on registration of public offers of securities; and Circular No. 38 on 18 April 2007 on disclosure of information. Trading regulations have not changed substantially over this period except for strict controls

on the price-change limit regulation in order to deal with stock-price declines in the market.¹⁰ However, the legal framework during the second period is argued to be a weak point due to a lack of regulations on insider trading and information disclosure (Vietnam Financial Review 2010).

On 12 November 2008, during the crisis period August 2008 - February 2009, the Law of Personal Income Tax (LPIT) was approved, regulating a tax rate of 25 per cent on capital gains and dividends earned in the stock market. The LPIT is the first regulation to take into account investor income earned in the stock market. However, as a result of sharp declines in the stock market, the implementation of this law was delayed until the end of 2010. Trading regulations in the market remain unchanged over the period; the government still strictly controls market regulations to avoid negative shocks due to the impacts of the GFC. Thus, some regulations in the Vietnamese equity market are viewed as incentive-based policies.

During the post-crisis period March 2009–December 2010, the government moved to push the market towards global integration as well as protecting it from the negative effects of the GFC. In particular, the amended Securities Law was approved in November 2010 to strengthen the securities-market operation - for example, by encouraging the listings activity of public firms in the Unlisted Public Company (UpCom) market, suggesting derivative products, encouraging cooperation of stock exchanges and enhancing information disclosure in the market. In addition, market regulations were gradually enhanced, such as increasing the price-change limit and preparing for a new trading order (market order). These regulations were issued in accordance with Vietnam's international commitments towards global integration. More details of recent trading regulations can be found in Appendix 3.2

Overall, although the laws and regulations in the Vietnam stock market have been gradually moving towards global integration, they are still strictly controlled by the government. In addition, some regulations - such as price-limit regulations and a delay in the implementation of the LPIT - are viewed as incentive-based policies.

¹⁰The price-change limit was adjusted to ± 1 per cent on 27 March 2008 and ± 2 per cent on 7 April 2008.

3.3 Market performance

To investigate the impacts of the GFC on the market, the market development of the Vietnamese equity market is separated into four periods as indicated in the market regulation. Overall, the market experienced significant progress in terms of market scale and listing activity over the periods.

3.3.1 Market development

With respect to market development, Figure 3.1 below shows that during the pre-crisis period, the aggregate market index (VN-Index) fluctuated significantly in the first year, then rose slightly in following years but dramatically increased in the period 2006–2007. Specifically, the VN-Index rose from 307 points to 927 points with an average growth rate of 72 per cent over the period 2005–2007. The highest market index of 1170.67 points occurred on 12 March 2007. In addition, market capitalisation increased from 0.5 per cent of GDP in 2004 to 27.5 per cent of GDP by the end of 2007 (see Table 3.2 below). The significant development of the Vietnamese equity market during the period 2006–2007 is often described as an ‘overheated’ period (Wilson 2007; Pincus and Anh 2008). This period can be explained by several factors. Firstly, the government offered support to foster market development by approving the Securities Law and made commitments to step up the equitisation process for state-owned enterprises. Second, impressive macroeconomic results were achieved in recent years, such as high annual economic growth rates, significant increases in FDI and stable inflation rates. Third, global integration was enhanced after Vietnam has become an official member of the World Trade Organization (WTO) in January 2007 and successfully organised international committees and forums in 2007 and 2008.

Figure 3.1: Movement of the aggregated equity-market index of Vietnam, 2000–2010

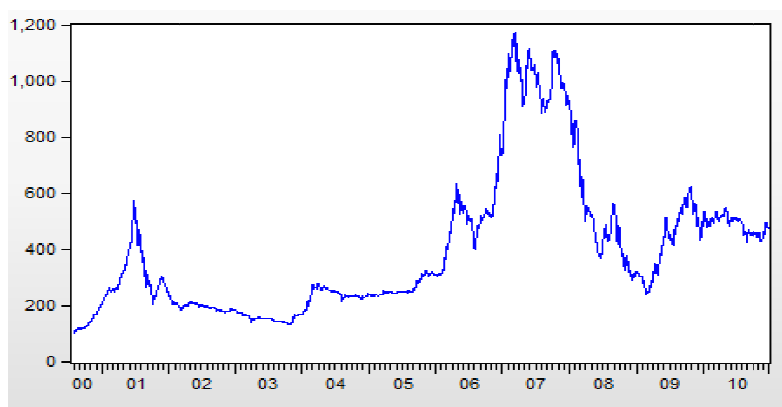


Table 3.2: Key indicators of the Vietnamese equity market, 2003–2010

	2003	2004	2005	2006	2007	2008	2009	2010
Market index	166	239	307	751	927	315	494	484
Number of listed company	22	26	33	102	121	171	196	275
Market capitalisation (US\$b)	0.15	0.25	0.46	9.1	19.5	9.6	21	20.3
Market capitalisation (% of GDP)	0.4	0.5	0.9	14.9	27.5	10.5	21.8	19.2
Stock trade (% of GDP)	31.2	24.8	22.4	87.9	44.8	141	82.7	31.2
Stock trade (turnover ratio %)	n/a	31.2	24.8	22.4	87.9	44.8	141	82.7

Source: World Bank Database

The crisis period brought massive challenges for the Vietnamese equity market. The lowest point for the market index was 235 points on 24 February 2009. By the end of 2008, the market index had slumped to 315 points, declining around 60 per cent from its peak in early 2007, and its market capitalisation as a percentage of GDP remained at 9.6 per cent. The market was considered one of the worst-performing in the world by the end of 2008 (Economist Intelligence Unit 2011).

During the post-crisis period, both the market index and market capitalisations recovered slightly. These fluctuations are similar to those described by Wang (2011) in the market performance of Asian equity markets as a result of the severe effects of the GFC in early 2008. However, in comparison with the market scales of regional and global markets, capitalisations and trading values were relatively small. In addition, as a result of its tiny trading values, the Vietnamese market is often regarded as a thin market (see Table 3.3 below). Details of the market indicators of the Vietnamese and several global equity markets can be seen in Appendix 3.3.

Table 3.3: Stock traded value in several Asian equity markets, 2010

	Korea	Malaysia	Singapore	Thailand	Vietnam
Market capitalisation (US\$b)	1,089	410	370	277	20.3
Market capitalisation (% of GDP)	107.3	172.6	173.6	87.1	19.2
Stock traded (US\$b)	1,626.6	90.2	282.1	217.9	29.4
Stock traded (% of GDP)	160.3	37.9	126.7	68.4	28.4
Stock traded, turnover ratio (%)	168.9	27.1	82.9	104.8	141.4

Source: World Bank Data

3.3.2 Listing activity

On the first trading day, 28 July 2000, only two companies, namely Refrigeration Electrical Engineering Joint Stock Company (REE) and Saigon Cable and Telecommunication Material Joint Stock Company (SACOM), were listed. The number of listed companies increased to 22 and 33 companies by the end of 2003 and 2005 respectively. Loc (2006) indicates that a lack of listing activities on the market during the period is mainly because of an unwillingness on the part of the board of directors of public companies. This is because (1) information disclosures on firm performances and strategies may cause trouble for listing firms, enabling their competitors to exploit the information and (2) listing firms did not realise the benefits of listing on the stock exchange.

A significant increase in the number of listed companies occurred in 2006 as a result of the government's efforts to develop the stock market. Specifically, the government issued regulations encouraging listing activity in the market by reducing corporate income tax by 50 per cent over the following two years if firms were approved for listing during the period 2004–2006. In addition, the government achieved positive results in the privatisation of state-owned enterprises, leading to a rapid increase in the number of listed firms. By the end of 2007, 121 companies were listed in the HOSE (see Table 3.2 above).

During the period 2008–2010, despite a large number of Vietnamese financial institutions listed in the market, such as Vietcombank, Vietinbank, Bao Viet Holding Group, and Eximbank, listing activities overall were quiet compared to the 2007–2008 period. This can be explained by the negative influence of the GFC on the operations of unlisted firms as well as market performance. In addition, as can be seen in Table 3.4 below, the number of companies listed in HOSE is relatively small in comparison to the number of listed firms in regional and global equity markets.

Table 3.4: A number of listed companies in several Asian equity markets, 2003–2010

	2003	2004	2005	2006	2007	2008	2009	2010
Hong Kong (Special Administrative Region of China)	972	1,014	1,020	1,021	1,029	1,017	1,308	1,396
India	5,644	4,730	4,763	4,796	4,887	4,921	4,955	4,987
Japan	3,116	3,220	3,279	3,362	3,844	3,299	4,161	3,553
Republic of Korea	1,563	1,573	1,620	1,694	1,767	1,798	1,778	1,781
Malaysia	897	962	1,020	1,027	1,036	977	953	957
Singapore	551	625	685	461	472	455	459	461
Thailand	421	464	504	518	475	476	535	541
UK	2,311	2,486	2,759	2,913	2,588	2,415	2,179	2,056
US	5,295	5,231	5,143	5,133	5,130	5,603	4,401	4,279
Vietnam	22	26	33	102	121	171	188	164

Source: World Federation of Exchange

Of note is the fact that a large number of listed companies in the Vietnamese equity market are privately stated-owned companies, while no foreign-owned companies (majority-owned by foreign investors) are listed. This is the result of regulations that limit foreign ownership of shares in listed firms at 49 per cent, with the exception of financial institutions for which foreign ownership is capped at 30 per cent.

The classification of listed firms by sectors shows that the three dominant sectors in the market are banking, real estate, and finance and securities, which together account for over 50 per cent of total market capitalisation (see Table 3.5 below). However, the characteristics of the market - being young with a strong growth rate in terms of listing firms - mean that the sectoral structure in the Vietnamese equity market is unstable and subject to change over time.¹¹

¹¹Due to a lack of available data on the market sector, the structure of listed firms is not discussed over time.

Table 3.5: Proportion of market sector in the Vietnamese equity market, 2010

Sector	Total market capitalisation (US\$m) ¹²	Percentage
Banking	7,666	24.11
Real estate	4,670	14.69
Finance and securities	3,795	11.94
Construction and materials	1,825	5.74
Other industry	2,405	7.56
Information technology	930	2.92
Gas	975	3.07
Consumer services	521	1.64
Pharmacy	413	1.30
Consumer goods	4,350	13.68
Material	3,287	10.34
Utility	955	3.00

Source: Au Viet Securities Company (2010)

In conclusion, although the Vietnamese equity market has developed significantly over the last 10-years, the market is still considered thin and small. This characteristic is in line with the view of Antoniou, Ergul and Holmes (1997), who consider thin trading a typical feature of emerging markets. In addition, the Vietnamese market is often regarded as a very immature market because of several limitations in the legal framework and the small market size.

3.4 Investor base in the market

3.4.1 Investor segmentation

Investors have a tendency to broaden their portfolios by holding assets in several countries to take advantage of the gains that arise from international diversification (Dicle, Beyhan and Yao (2010) Therefore, investors in equity markets are often classified into two main groups: domestic and foreign investors (Dvorák 2005; Covrig, Lau and Ng 2006; Ko, Kim and Cho 2007).

After 10 years of operation, the number of investors in the Vietnamese equity markets has significantly increased, especially in recent years. The number of investor trading accounts rose from 21,600 in 2004 to over 1,056,000 by the end of 2010 (see Table 3.6 below).

In terms of investor segmentation, domestic investors were the dominant group in the market, maintaining over 98 per cent of trading accounts by the end of 2010. Foreign investors held

¹²Exchange rate used to convert the market capitalisation into US\$ was 19,500 VND/USD on 31/12/2010.

less than 2 per cent. These ratios are not surprising for a young market like Vietnam and support the argument of little cross-border diversification by investors in the market. Among domestic investors, a large proportion (over 98.7 per cent) were individual investors with over 1 million trading accounts, while institutional investors maintained 13,840 trading accounts (1.3 per cent) (Ho Chi Minh Stock Exchange 2011).

Table 3.6: Investor structure in the Vietnamese stock market

Year	2004	2005	2006	2007	2008	2009	2010
Number of investor trading accounts							
Domestic investors	21,409	30,880	104,293	340,961	519,409	810,200	1,043,100
Foreign investors	207	436	2,100	8,441	11,941	12,700	13,840
Total	21,616	31,316	106,393	349,402	531,350	822,900	1,056,940
Trading values (trillion VND ¹³)							
Domestic investors	n/a	2.44	23.60	136.84	80.97	358.16	287.90
Foreign investors	n/a	0.56	11.40	81.00	44.60	64.30	70.10
Total		3.00	35.00	217.84	125.57	422.46	358.00

Source: Calculated from the annual reports of Ho Chi Minh Stock Exchange

With respect to the impacts of the GFC on the markets, changes in the investor base document certain impacts. Specifically, during the pre-crisis period, the investor base in the market increased significantly, reaching nearly 350,000 investor trading accounts and VND 220 trillion by the end of 2007. Similarly, the number of foreign investors increased considerably, rising from around 200 accounts in 2004 to over 8,441 accounts in 2007. It is notable that although the proportion of foreign investors was relatively small, their trading values have comprised around 20 per cent in recent years (Ho Chi Minh Stock Exchange 2010, 2011). The significant increases in the trading values as well as trading accounts of foreign investors can be explained by several factors. Firstly, the Vietnamese equity market has become more integrated with global markets as Vietnam officially became a member of the WTO on 11 January 2007. Second, the legal framework of the market has gradually become stronger, especially when the first Securities Law of Vietnam was approved by the National Assembly on 29 June 2006. Third, barriers to capital flows have been steadily removed, paving the way to global integration.

As a result of the negative effects of the GFC, foreign investors became concerned about the difficulties experienced by the Vietnamese economy and, subsequently, foreign investor trading values declined slightly in 2008. However, trading values rose impressively in the

¹³VND = Vietnamese dong

period 2009–2010, suggesting that the positive results of the Vietnamese economy during the recovery period has led to increased interest.

3.4.2 Investor characteristics

It is often argued that a large number of domestic investors in the Vietnamese equity market are new and inexperienced (Dung 2007; Ha 2007). Ly (2010) indicates that in spite of representing the largest segment of the market, domestic investors are inexperienced and possess weak analytical skills. Therefore, they are almost always followers in securities trading (My & Truong 2011). In addition, Dung (2007) and the Vietnam Financial Review (2010) suggest a high level of short-term and speculative trading among domestic investors. Foreign investors are often reported as being market leaders because their trading activities heavily influence market behaviour (Ly 2010). This argument is in line with findings by Hong and Lee (2011), who support the leading role of foreign investors in emerging markets.

Dung (2010) claims that investors in the Vietnamese equity market have strong skills in financial analysis. The author examines a relationship between financial-statement information and stock prices for the period 2003–2007 and finds statistically significant results in the relationships between financial ratios of listed firms (for example, earnings ratio, book value) and the Vietnamese equity-market index. This linkage became stronger during the stock-market boom in 2006 and early 2007. However, he also argues for the relatively weak value of financial-statement information in Vietnam as a result of problems in the legal framework surrounding information disclosure, accounting regime and auditing activities. This argument is in line with Farber, Nam and Hoang (2006), who show limitations on information disclosed on the Vietnamese stock market. This could result in trading based on investor sentiment in the market.

In summary, the largest segment of the investor base in the Vietnamese equity market is domestic investors who are characterised as new, inexperienced and followers. Foreign investors maintain a relatively small number of trading accounts but are seen as market leaders. Although the GFC resulted in some changes in the investor base, it remains to be seen how these changes have affected market returns and linkages between the Vietnamese and other equity markets.

3.5 Market environment influencing cross-market linkages

Further to the discussion on sources of market linkages in Chapter 2, several factors in the market environment can be considered sources of linkages between the Vietnamese and global markets. This section discusses these factors, including fundamental factors, market regulations, market information and investor behaviour.

3.5.1 Fundamental factors

Fundamental factors and their impacts on stock prices have been examined extensively in the empirical finance literature (Yasushi 1988; Wongbangpo and Sharma 2002; Benjamin 2008; Nikiforos 2011). Commonly used factors in these studies are gross domestic production, consumer price index, money supply, industrial production, interest rate, exchange rate and oil price, but their findings are not completely consistent.

As Vietnam is a young market, studies on the link between stock prices and market fundamentals are relatively limited. Most extant studies focus on factors such as oil prices (Narayan & Narayan 2010), exchange rates (Hsu-Ling, Chi-Wei and Yi-Chu 2009; Narayan and Narayan 2010), and interest rates and industrial production (Hussainey & Ngoc 2009). Almost all of these studies examine the impacts of these factors on market returns rather than market linkages. However, these fundamental factors imply, to a certain extent, indirect impacts on the cross-market linkages of the Vietnamese equity market.

For example, Narayan and Narayan (2010) examine the effects of oil prices and nominal exchange rates on Vietnamese stock prices over the period 2000–2008. The authors find evidence of a long-run relationship among the factors. However, insignificant statistics for the short-run linkage from both oil prices and exchange rates to stock prices are also revealed. Similar results are reported in the study by Hsu-Ling, Chi-Wei and Yi-Chu (2009), who use time series data from 28/7/2000–29/12/2006 and find significant evidence of volatility transmission between exchange rates and stock prices in Vietnam.

Global fundamental factors are also statistically significant for market prices in Vietnam. Hussainey and Ngoc (2009) examine the impacts of US interest rates and industrial production on Vietnamese stock prices and report evidence of positive effects of industrial

production on stock prices. Although the study has some limitations, such as a shortage of available data on market variables and a relatively short period of study, it suggests a linkage between the Vietnamese stock market and the fundamental factors of the US, and raises concern about shock transmission from US-market volatilities to the Vietnamese stock market.

3.5.2 Market regulation

Empirical studies of equity-market linkages often take into account the linkages between market regulations and market returns. Several regulations commonly discussed in the existing literature are margin requirements (Hsieh and Miller 1990; Lee and Yoo 1993), price-change limits (Su & Fleisher 1998) and foreign-investment opportunities (Holmes & Wong 2001). In an emerging market like Vietnam, the influences of market regulation are often expected to be significant. However, due to the Vietnamese stock market's lack of published data, almost all studies on market regulation are associated with the price-limit regulation (see Hoang (2004) Farber, Nam and Hoang (2006) Ha (2007)). Ha (2007) shows that the price-limit regulation is used to prevent a market from short-term reactions that may lead to high volatility, or to provide time for rational assessments by investors during periods of shock. Therefore, price-limit regulations are often used in the market to protect it from short-term speculations and negative effects caused by shocks.

In an early study of the Vietnamese equity market, Hoang (2004) uses the generalised autoregressive conditional heteroskedasticity (GARCH) model to capture the effects of regulations on daily stock returns in the period 2000–2003 and shows that market returns are very sensitive to regulations, particularly price-limit regulations. A further study by Farber, Nam and Hoang (2006) extends the period of study to May 2004, and similarly finds evidence of anomalies in stock returns owing to price-limit regulations. Moreover, the authors show that the phenomenon of limit-hits occurs quite frequently in the early stage of the market, and weakens during the stable period.

By classifying the magnitude of returns in relation to the limit-prices into upward and downward groups, Ha (2007) finds evidence in favour of a delayed price discovery of stocks after the day of a limit-hit. In addition, the movements of stock prices have a tendency to continue on the next day. The results also indicate asymmetric effects of price limits on different price directions as investors often react more in upward rather than downward price

movements. The author further explains these findings as a result of the prohibition of short sales as well as biased recommendations by analysts in the market.

To sum up, empirical findings associated with the effects of price-limit regulations on volatility in the Vietnamese equity market document a delay in the discovery process of stock prices towards their equilibrium on the day of a limit-hit, which may continue to affect market prices on subsequent days. Therefore, the price-limit regulation could be considered an indirect factor influencing cross-market linkages between the Vietnamese and global markets.

3.5.3 Market information

Information is extremely important for investment decision-making and directly affects market-price movements (Charest 1978; Badrinath, Kale and Noe 1993; Dvorák 2005; Kim 2005; Savor 2012). Due to limitations in information disclosure, studies associated with information in the Vietnamese equity market are extremely sparse. For example, a study by Hoang (2004) uses the GARCH model to investigate the impacts of good and bad news on the volatility of the stock market. The author finds that information has different effects on stock prices depending on the time of their occurrence and the type of information being disclosed. Moreover, Hoang documents that bad news increases the volatility of stock returns strongly and directly.

A recent report on global competitiveness by the World Economic Forum (Schwab 2012) documents a weak investor-protection index in the Vietnamese equity market (at 137th of 142).¹⁴ This information reveals a weak point in information transparency in the Vietnamese equity market. Weak market information in the market may result in biases in the trading behaviour of investors.

3.5.4 Investor behaviour

Numerous studies have documented linkages between investor behaviour and market returns (Yang 2002; Oh, Parwada and Walter 2008; Chiang et al. 2012). More recent studies examine this in the context of behavioural finance and give regard to investor mood, perception and

¹⁴The index is a combination of the transaction disclosure index, director ability index and ease of shareholder suit index.

sentiment (Bowe and Domuta 2004; Shu 2010; Chau, Deesomsak and Lau 2011; Hoffmann, Post and Pennings 2012). As a result of limitations in investor information, studies of investor behaviour in the Vietnamese equity market are mostly related to investor sentiment. Two prominent investor behaviours taken into consideration are herd behaviour and the day-of-the-week effect.

3.5.4.1 Herd behaviour

Herd behaviour can be defined as a tendency to imitate the actions of other investors (Hirshleifer and Hong Teoh 2003; Farber, Nam and Hoang 2006) and could be an alternative explanation for trading behaviours of investors in national and global-equity markets. Demirer and Kutan (2006) explain that herd behaviour emerges when investors are more likely to suppress their beliefs in favour of market consensus. In other words, a common feature of herd behaviour is that individual trading decisions are often based on collective trading tendencies.

Over the past decades, herd behaviour has been of interest to many researchers and practitioners. It has become a crucial factor discussed in the area of behavioural finance (Chang, Cheng & Khorana 2000), especially in studies associated with emerging equity markets (Chang, Cheng and Khorana 2000; Demirer and Kutan 2006; Kallinterakis 2009; Demirer, Kutan and Chen 2010; Lao and Singh 2011). Kallinterakis (2009), for instance, indicates that emerging markets commonly have incomplete regulatory frameworks and limited transparency. Thus, investor behaviours are easily influenced by rumours and manipulations. In addition, several studies find evidence of increased herding during periods of market loss (Chang 2010) and dominant herding among foreign investors during crisis periods (Bowe & Domuta 2004).

In the context of the Vietnamese equity market, herd behaviour is examined in several studies including My and Truong (2011); Farber, Nam and Hoang (2006); Ha (2007); Kallinterakis (2007); and Ly (2010). A study by Farber Nam and Hoang (2006) uses daily data for the period 2000–2004 and finds evidence of herding in HOSE. Ha (2007) finds asymmetry in investor trading in the Vietnamese equity market because herd behaviour is more significant in days after positive price changes than negative ones.

Kallinterakis (2009) examines herd behaviour in the Vietnamese equity market, and finds that it significantly disappears when data is corrected for thin trading. The author explains a bias towards evidence of herding due to an illiquid structure in the thin equity market of Vietnam.

Another study by My and Truong (2011), examines herd behaviour in the Vietnamese equity market by separating data into the rising period (3/3/2002–1/1/2006) and declining period (2/1/2006–20/7/2007). The findings show that herding is more prominent in the declining period than in the rising period. The authors explain the results by a set of limitations in market regulations, high market volatility and thin trading.

3.5.4.2 Day-of-the-week effect

One of the seasonal anomalies investigated in the context of the Vietnamese equity market is the day-of-the-week effect.¹⁵ This effect can be described as an abnormal return in the stock market on some days of the week compared to other days (Loc 2012). A number of empirical findings support the existence of the day-of-the-week effect in global equity markets (see Dubois and Louvet (1996) Chen, Kwok and Rui (2001); Hui (2005); Bodla and Jindal (2006); Ke, Chiang and Liao (2007)).

In the Vietnamese equity market, the day-of-the-week effect was first investigated by Loc (2006). Using market returns over the period May 2002–August 2005, Loc finds a negative Tuesday effect. A similar finding is found by Hau (2010), who examines the day-of-the-week effect in the market indices of the US, Japan, France, Hong Kong, the UK, Singapore, Malaysia and Vietnam over the period 1/3/2002–31/5/2008.

A recent study by Loc (2012) using equity-market returns and volatilities from 1 March 2002 to 1 March 2011 confirms the day-of-the-week effect on both stock returns and volatility in the Vietnamese stock market. The author also suggests other evidence of abnormal seasonality, including a positive effect on Friday, the highest volatility on Thursday and the lowest volatility on Monday.

¹⁵Seasonal anomalies refer to a wide range of anomalies of market returns such as the day-of-the-week effect, the weekend effect, the semi-monthly effect, the January effect and the turn-of-the-month effect (Bodla and Jindal 2006, Loc 2012).

3.6 Chapter conclusion

Although the Vietnamese equity market has achieved significant results in terms of market size and performance, it is still regarded as a young, small and thin emerging market. The market retains a number of limitations such as an incomplete and strict regulation framework, illiquidity and a tiny trading volume. In addition, previous studies of the Vietnamese equity market show empirical evidence of linkages between market environmental factors and market returns. Therefore, significant changes in the environment of the Vietnamese equity market during the pre- and post-GFC periods may affect linkages between the Vietnamese and other equity markets.

Chapter 4: Data Collection and Research Methodology

4.1 Overview

In Chapter 3, the Vietnamese equity market was identified as being severely impacted by the GFC and to have followed a similar direction to global equity markets over the period of the GFC. Bearing this in mind, this thesis questions whether market linkages exist between and among the Vietnamese and global markets, and how these linkages have changed under the impacts of the GFC. In Chapter 2, we identified and discussed the three dominant linkages among global markets, namely co-integration, causality and contagion. This chapter describes the data collection process and sample size used. A preliminary analysis of data is also presented. In addition, empirical methods associated with the three dominant linkages are discussed. The structure of the chapter is as follows. Section 4.2 discusses data and the data sample. Section 4.3 provides an overview of the models used in the tests and section 4.4 concludes.

4.2 Data and sample

As discussed in Chapter 3, Vietnam has two stock exchanges, of which the HOSE is generally considered the main one. Accordingly, in this thesis, we use the aggregated market index of the HOSE (VN-Index) as the benchmark market index for the Vietnamese equity market. According to reports by the Organization for Economic Cooperation and Development (2009), nearly 70 per cent of Vietnam's FDI flows are sponsored by Taiwan, Korea, Singapore, Japan, Malaysia, US, Hong Kong and Thailand (see Table 4.1 below). These countries also continuously maintain leading positions in the FDI flows of Vietnam in recent years. Therefore, with the purpose of examining equity-market linkages between the Vietnamese and other markets, this thesis uses the benchmark market indices of these countries: the TWSE Composite Index (Taiwan), the KSE Composite Index (Korea), the Strait Times Index (Singapore), the Nikkei 225 Stock Average (Japan), the KLSE Composite Index (Malaysia), the S&P 500 Composite Index (US), the Hong Hang Seng Index (Hong Kong) and the SET Index (Thailand) (see Table 4.2 below).

Table 4.1: Foreign direct investment in Vietnam by investing country, 1988–2008

Country	Percentage
Taiwan	11.8
Korea	11.5
Singapore	11.3
Japan	10.8
Malaysia	9.5
US	6.8
Hong Kong	4
Thailand	3
Total	69.1

Source: Organization for Economic Cooperation and Development 2009

Table 4.2: Benchmark equity-market indices

Country	Benchmark index	Abbreviation
Vietnam	HO CHI MINH VSE PRICE INDEX	VN
Hong Kong	HANG SENG PRICE INDEX	HK
Taiwan	TAIWAN SE WEIGHTED PRICE INDEX	TW
Korea	KOREA SE COMPOSITE (KOSPI) PRICE INDEX	KR
Singapore	STRAITS TIMES INDEX PRICE INDEX	SG
Japan	NIKKEI 225 STOCK AVERAGE PRICE INDEX	JP
Malaysia	FTSE BURSA MALAYSIA KLCI PRICE INDEX	ML
US	S&P 500 COMPOSITE PRICE INDEX	US
Thailand	BANGKOK SET PRICE INDEX	TL

The key market development indicators are summarised in Table 4.3 below. The table highlights the largest market capitalisation of the US equity market relative to the other markets under consideration, at US\$17,138 billion. Vietnam has the lowest market capitalisation relative to the other markets in the sample, at about US\$20.3 billion. Stock trading values as a percentage of GDP show the highest ratio for Hong Kong (at 711.7 per cent) suggesting Hong Kong is a large equity market in the region. The turnover ratio (the ratio of market trading value to market size), measuring the liquidity of these markets, report that the US is the most liquid market in the sample. Interestingly, the turnover ratio is relatively impressive in the Vietnamese equity market (at 82.7 per cent), suggesting a relatively dynamic characteristic of an emerging market.

Table 4.3: Development indicators of selected equity markets, 2010

	Stocks traded, turnover ratio (%)	Listed companies	Market capitalisation (US\$b)	Market capitalisation (% of GDP)	Stocks traded, total value (% of GDP)
Vietnam	82.7	275	20.3	19.2	16.2
Hong Kong	160.1	1,396	1,079	481	711.7
Taiwan	n/a	784	818	n/a	n/a
Korea	168.9	1,781	1,089	107.3	160.3
Singapore	82.9	461	370	173.6	132.4
Japan	114.5	3,553	4,099	74.7	78
Malaysia	27.1	957	410	172.6	37.9
US	189.1	4,279	17,138	118.6	210.8
Thailand	104.8	541	277	87.1	68.3

Source: World Bank Database and World Federation of Exchange database, viewed 12 April 2012

Among these markets, Vietnam has the shortest period of study because its first trading day was 28 July 2000. Thus, for the purposes of this thesis, linkages between and among the markets are examined using the equity-market data collected 28 July 2000–31 December 2010. In addition, to better capture the effects of the GFC on the interdependences as well as the dynamic linkages among the markets over time, high-frequency data is more appropriate compared to weekly or monthly data. Therefore, the daily data is used, covering 2,721 observations of each series.

As discussed by Chan Leong and Felmingham (2003) and Yang and Lim (2004), market indices in local currency can capture the influences of local economic policy and conditions of market linkages. Hence, the time series data set of the equity-market indices used in the thesis is expressed in local currency. The data is collected from DataStream International. For non-trading days, it is assumed that market-index values remain unchanged from the previous trading day.

4.2.1 Data processing

As this thesis uses time series data for nine equity-market indices for countries with different histories and market developments, the market indices of these countries are scaled to start from 100 on the first day in the period of study (28 July 2000). In other words, all market indices on an initial date are converted to equal 100. This is done to better observe co-movements among the markets.

To examine the linkages between and among the Vietnamese and other markets, the natural logarithms of the market indices are calculated to express the market levels as given in equation 4.1 below. These series are used to examine the co-integration relationship among the markets:

$$\text{Market_level}_{\text{day } t} = \ln(\text{Market_index}_{\text{day } t}) \quad [4.1]$$

The first differences of logarithms of market indices multiplied by 100 are constructed to measure the market returns of the selected markets. These market returns will be used to investigate the causal linkage and contagion effect across the markets as shown in equation 4.2 below:

$$\text{Market_return}_{\text{day } t} = (\text{Market_level}_{\text{day } t} - \text{Market_level}_{\text{day } (t-1)}) \times 100 \quad [4.2]$$

As daily data is used in this thesis, we capture the potential limitation caused by trading-hour differences among markets. As shown in Table 4.4 below, the trading hours of Asian markets are overlapping while those of the US equity market are one day lagged. Thus, the equity market levels and returns of the US are lagged one day compared to those of the other series data.

Daily equity-market levels and returns of the nine markets are divided into two sub-groups: advanced and emerging economies. Emerging economy classifications are in line with the classification of the International Monetary Fund (2010a). Accordingly, Japan, Korea, Taiwan, Hong Kong, Singapore and the US are classified as advanced economies, while Malaysia, Vietnam and Thailand are classified as emerging economies.

Table 4.4: Trading hours of selected market indices

Group	Market	Trading hours (local time)	Trading hours (Eastern Standard Time, New York)
Advanced economy	Japan	09:00–15:00	23:00–05:00 (t+1 day)
	Taiwan	09:00–13:30	22:00–02:30 (t+1 day)
	Hong Kong	10:00–16:00	23:00–05:00 (t+1 day)
	Korea	09:00–15:00	23:00–05:00 (t+1 day)
	Singapore	09:00–17:00	22:00–06:00 (t+1 day)
	US	09:30–16:00	09:30–16:00
Emerging economy	Malaysia	08:30–17:00	21:30–06:00 (t+1 day)
	Thailand	09:00–17:00	21:00–05:00 (t+1 day)
	Vietnam	08:30–11:00	20:30–23:30

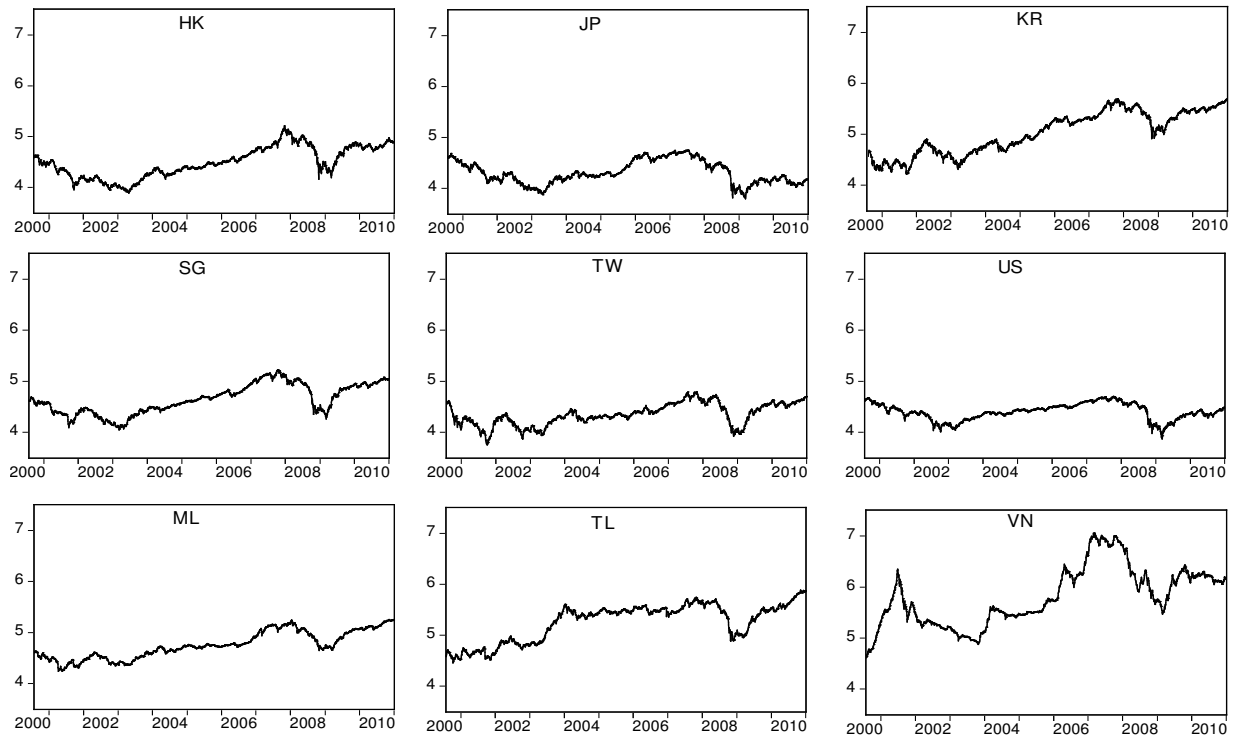
To examine the impacts of the GFC over the period of study, the entire period of study is broken into three: the pre-crisis, crisis and post-crisis periods. The division of time into periods raises questions around distinguishing between pre- and post-crisis periods. Some extant studies propose that the GFC started in mid-2007, which was when the US subprime crisis occurred (Glezakou and Mylonakis 2010; Naoui, Liouane and Brahim 2010; Chakrabarti 2011; Guo, Chen and Huang 2011), while others propose a starting time of early 2008 (Saha and Chakrabarti 2011; Samarakoon 2011) or mid-2008 (Bartram and Bodnar 2009; Dooley and Hutchison 2009; Syllignakis and Kouretas 2011). In all of these studies, the crisis period is determined by visually inspecting the movements of markets indices over periods of study.

Accordingly, in this thesis, we inspect time series of market levels and returns for these countries' equity markets. As Figure 4.1 below (panel A) indicates, levels in almost all markets under consideration followed an upward trend over the 2003–2007 period. Steep falls followed from 2007 to 2008 and then there was a slight increase during the first half of 2009. Similar results are documented in the graphs on market returns, showing clusters of market volatilities over the crisis period from 2007 to 2008. Figure 4.1 (panel B) also shows that the period of high volatility varies by country. Specifically, while the US and Japan illustrate high volatility of market returns starting from the second half of 2008, Hong Kong and Singapore show significant changes from mid-2007. However, almost all markets show support for a breaking date of September 2008, coinciding with US government's decision to assume control of the Federal National Mortgage Association ('Fannie Mae') and the Federal Home Loan Mortgage Corporation ('Freddie Mac'). In addition, a number of studies indicate a recovery of global equity markets at the beginning of March 2009 (Dooley and Hutchison 2009; Chakrabarti 2011; Saha and Chakrabarti 2011). As such, the entire data set used in this thesis is separated into three sub-periods:

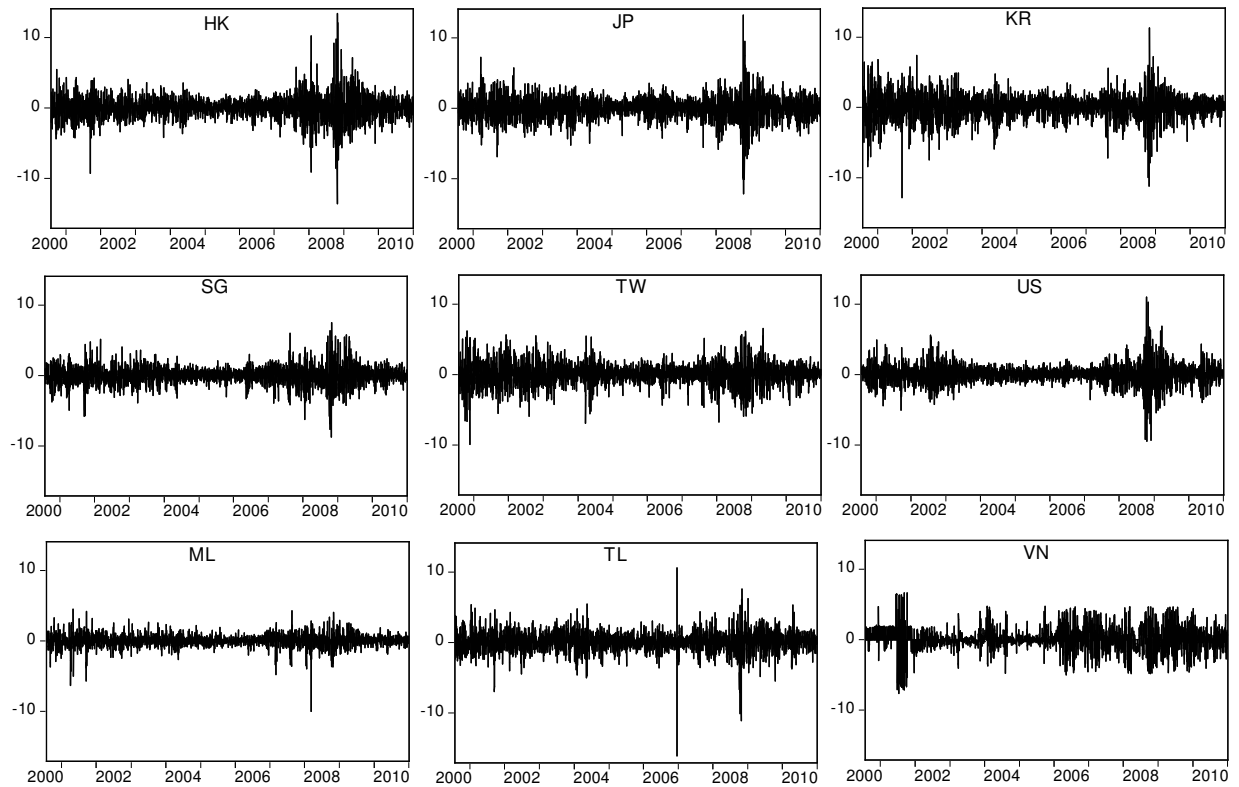
- Period 1: a pre-crisis period (28 July 2000–30 August 2008), comprising 2,111 observations for each series
- Period 2: a crisis period (1 September 2008–28 February 2009), comprising 130 observations for each series
- Period 3: a post-crisis period (1 March 2009–31 December 2010), comprising 480 observations for each series.

Figure 4.1: The movements of market levels and market returns

Panel A: Market levels



Panel B: Market returns



These sub-periods are consistent with the descriptions of international stock-market movements by Krishnamurthy (2010) and Mishkin (2011), and the analysis on the role of news by Dooley and Hutchison (2009).

4.2.2 Descriptive analysis

Descriptive statistics of the logarithms of equity-market indices of the sample are presented in Table 4.5 below. The results show that Vietnam exhibits both the highest mean and standard deviations of equity-market levels, at 5.81 and 0.58 respectively. The lowest means of market levels are in Japan (4.31) and Taiwan (4.35), while the lowest standard deviations of market levels are in the US (0.16) followed by Taiwan (0.22) and Japan (0.23). It is noteworthy that the means and standard deviations are overall higher across the three emerging markets than the six advanced markets. These findings imply higher market volatilities in the emerging markets in the sample. This is the case for all periods examined.

Partitioning the sample into the pre- and post-crisis periods, the table also shows that almost the highest means of market levels are found in Vietnam over the pre-crisis (5.74), crisis (5.84) and post-crisis (6.14) periods. In the meantime, Taiwan reveals the lowest mean (4.33) over the pre-crisis period while Japan reports the lowest over the crisis and post-crisis periods (4.04 and 4.12 respectively). In addition, in all periods, the market volatilities (as measured by standard deviation) are almost higher in the three emerging markets compared to the advanced markets. Of the emerging markets, Malaysia is the least volatile.

The skewness values are negative in some market levels in the pre- and post-crisis periods but positive in all markets in the crisis period, indicating that the series skews to the left in some cases and to the right in other cases. This implies that the statistical distributions of the market levels are not in balance around their means. The kurtosis values are not high (less than 3) in the market levels for the pre- and crisis-periods; however, they are relatively high in the post-crisis period, implying that the distribution of peaks is relatively normal in pre- and crisis periods and not normal in the post-crisis period. Finally, the Jarque–Bera results are highly significant for all series, confirming a rejection of the hypothesis of a normal distribution for the time series during the sample periods.

Table 4.5: Descriptive statistics of equity-market levels

	Advanced markets						Emerging markets		
	HK	JP	KR	SG	TW	US	ML	TL	VN
Entire period (28/7/2000–31/12/2010)									
Mean	4.49	4.31	5.03	4.64	4.35	4.40	4.75	5.26	5.81
Median	4.47	4.27	5.07	4.62	4.34	4.41	4.73	5.43	5.73
Maximum	5.22	4.75	5.70	5.22	4.79	4.70	5.25	5.89	7.07
Minimum	3.89	3.80	4.21	4.04	3.75	3.86	4.24	4.45	4.61
Std dev.	0.30	0.23	0.42	0.29	0.22	0.16	0.26	0.37	0.58
Skewness	0.08	0.20	−0.15	0.02	−0.18	−0.40	0.16	−0.60	0.31
Kurtosis	2.05	2.04	1.67	1.96	2.34	2.67	1.93	1.99	2.29
Jarque–Bera	104.40	122.70	209.99	123.08	64.23	83.77	140.60	277.25	100.25
Pre-crisis period (28/7/2000–30/8/2008); 2,111 observations									
Mean	4.44	4.37	4.92	4.60	4.33	4.43	4.69	5.22	5.74
Median	4.39	4.33	4.83	4.57	4.31	4.44	4.68	5.42	5.53
Maximum	5.22	4.75	5.70	5.22	4.79	4.70	5.25	5.75	7.07
Minimum	3.89	3.87	4.21	4.04	3.75	4.00	4.24	4.45	4.62
Std dev.	0.30	0.22	0.40	0.29	0.21	0.15	0.25	0.38	0.62
Skewness	0.44	−0.09	0.24	0.28	0.02	−0.49	0.45	−0.53	0.63
Kurtosis	2.43	2.05	1.80	2.15	2.62	2.68	2.31	1.67	2.35
Jarque–Bera	95.26	83.07	147.33	90.21	13.23	92.42	114.32	257.16	177.02
Crisis period (1/9/2008–28/2/2009); 130 observations									
Mean	4.46	4.04	5.14	4.52	4.08	4.19	4.74	5.08	5.84
Median	4.42	3.99	5.12	4.45	4.03	4.14	4.72	5.03	5.75
Maximum	4.81	4.39	5.38	4.90	4.43	4.50	4.93	5.44	6.33
Minimum	4.16	3.81	4.91	4.35	3.92	3.96	4.64	4.88	5.46
Std dev.	0.15	0.16	0.12	0.16	0.13	0.14	0.07	0.16	0.21
Skewness	0.89	1.05	0.51	1.16	1.15	0.95	1.05	1.11	0.70
Kurtosis	2.81	2.87	2.44	2.95	3.07	2.78	2.96	2.98	2.70
Jarque–Bera	17.25	24.12	7.34	29.05	28.48	19.98	24.00	26.60	11.12
Post-crisis period (2/3/2009–31/12/2010); 480 observations									
Mean	4.76	4.12	5.46	4.86	4.51	4.31	5.05	5.51	6.14
Median	4.80	4.13	5.48	4.91	4.54	4.34	5.07	5.52	6.19
Maximum	4.98	4.27	5.69	5.08	4.70	4.49	5.25	5.89	6.44
Minimum	4.19	3.80	4.99	4.26	4.00	3.86	4.65	4.95	5.49
Std dev.	0.15	0.08	0.13	0.17	0.13	0.12	0.14	0.23	0.18
Skewness	−1.76	−1.22	−0.93	−1.62	−1.55	−1.21	−0.89	−0.52	−1.76
Kurtosis	6.09	5.87	4.19	5.27	5.57	4.19	3.37	2.96	6.20
Jarque–Bera	438.62	283.51	97.64	313.31	325.47	145.38	66.57	21.97	452.17

The descriptive statistics for the market returns of the nine series under investigation for the entire sample and sub-periods are given in Table 4.6 below. The results show that the Vietnamese equity market exhibits the highest mean (0.06) and standard deviation (1.68) of market returns in comparison with those of the other markets in the sample over the entire

period. However, the results also indicate that the variation between a maximum and minimum of market returns for Vietnam is lower compared to the other markets. This may be due to the impacts of strict regulations on market trading and capital controls imposed by the Vietnamese governments. Of the other markets in the sample, the lowest mean is found in Japan (-0.02), while the highest standard deviation is found in Korea (1.68). The distribution of return series appears to be non-normal as a result of high kurtosis values in all markets. In addition, almost all returns have negative skewness, implying a long right tail in return distributions. The high values of Jacque–Bera statistics confirm that the returns series of these markets are not normally distributed over the sample periods.

The descriptive statistics also illustrate high fluctuations in the means and standard deviations among the market returns over the sub-periods. In the pre-crisis period, the highest mean is in Vietnam (0.08) while the lowest mean is in Japan (-0.01). The highest standard deviation is in Korea (1.64) and the lowest is in Malaysia (0.89). Notably, the higher means are found in the emerging markets as against the advanced markets, with the exception of Korea.

In the crisis period, all the markets experience negative means of market returns ranging from -0.16 (Malaysia) to -0.60 (Vietnam). In addition, the standard deviations of the market returns relatively increase during the period, from 1.25 (Malaysia) to 3.81 (Hong Kong). The results suggest that the effect of the GFC was strong on the market returns under observation. Of the markets, Vietnam and the US are considered the most influenced because of their low means of market returns, at -0.60 and -0.43 respectively. It is noteworthy that the standard deviations across the advanced markets are higher than those of the emerging markets, supporting high fluctuations of the advanced markets' returns during the period. In addition, almost all the market returns have positive skewness, except Korea and Thailand, implying that the return distributions have long left tails, and the kurtosis values remain high, implying that the distributions are peaked relative to normal.

Table 4.6: Descriptive statistics of equity-market returns

	Advanced markets						Emerging markets		
	HK	JP	KR	SG	TW	US	ML	TL	VN
Entire period (28/7/2000–31/12/2010)									
Mean	0.01	−0.02	0.04	0.02	0.00	−0.00	0.02	0.05	0.06
Median	0.00	0.00	0.06	0.00	0.00	0.02	0.01	0.00	0.00
Maximum	13.41	13.23	11.28	7.53	6.52	10.96	4.50	10.58	6.66
Minimum	−13.58	−12.11	−12.80	−8.70	−9.94	−9.47	−9.98	−16.06	−7.66
Std dev.	1.60	1.57	1.68	1.28	1.54	1.35	0.87	1.42	1.68
Skewness	0.04	−0.28	−0.51	−0.16	−0.24	−0.11	−0.98	−0.79	−0.23
Kurtosis	11.88	9.72	8.30	7.47	5.80	11.37	13.96	14.12	5.69
Jarque–Bera	8,928	5,152	3,306	2,273	913	7,947	14,064	14,300	844
Pre-crisis period (28/7/2000–30/8/2008)									
Mean	0.01	−0.01	0.04	0.01	−0.01	−0.00	0.02	0.04	0.08
Median	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	10.18	7.22	7.36	5.98	6.17	5.57	4.50	10.58	6.66
Minimum	−9.29	−6.86	−12.80	−6.22	−9.94	−5.05	−9.98	−16.06	−7.66
Std dev.	1.36	1.38	1.64	1.15	1.53	1.08	0.89	1.34	1.60
Skewness	−0.17	−0.14	−0.46	−0.22	−0.24	0.10	−1.18	−0.67	−0.27
Kurtosis	8.03	4.65	6.92	5.64	5.82	5.43	15.32	15.91	7.03
Jarque–Bera	2,235	246	1,424	627	721	523	13,842	14,802	1,451
Crisis period (1/9/2008–28/2/2009)									
Mean	−0.39	−0.42	−0.25	−0.42	−0.34	−0.43	−0.16	−0.35	−0.60
Median	−0.06	−0.02	−0.01	−0.47	0.00	−0.15	−0.14	0.00	−0.48
Maximum	13.41	13.23	11.28	7.53	6.10	10.96	4.06	7.55	4.64
Minimum	−13.58	−12.11	−11.17	−8.70	−5.93	−9.47	−3.68	−11.09	−4.80
Std dev.	3.81	3.66	3.25	2.69	2.38	3.51	1.25	2.68	2.33
Skewness	0.39	−0.07	−0.21	0.14	0.08	0.10	0.17	−0.66	0.19
Kurtosis	5.30	5.08	4.77	3.96	3.32	3.93	4.55	6.21	2.43
Jarque–Bera	32.02	23.52	17.98	5.39	0.69	4.94	13.60	65.21	2.55
Post-crisis period (2/3/2009–31/12/2010)									
Mean	0.12	0.06	0.14	0.14	0.14	0.11	0.11	0.18	0.14
Median	0.03	0.00	0.13	0.12	0.12	0.09	0.07	0.16	0.07
Maximum	7.15	5.03	4.21	5.77	6.52	6.84	2.53	5.29	4.65
Minimum	−4.97	−4.64	−4.80	−4.24	−4.39	−4.77	−1.87	−5.44	−4.67
Std dev.	1.55	1.43	1.14	1.22	1.24	1.32	0.64	1.28	1.77
Skewness	0.22	0.03	−0.37	0.48	−0.08	0.15	0.26	−0.30	−0.06
Kurtosis	4.48	3.76	4.93	6.38	5.97	6.10	4.74	4.86	3.33
Jarque–Bera	47.98	11.65	85.79	246.98	176.59	193.49	66.09	76.61	2.51

In the post-crisis period, the means of market returns of all the markets in the sample increase considerably, from 0.06 (Japan) to 0.18 (Thailand), while the standard deviations of market returns decline relatively, from 0.64 (Malaysia) to 1.77 (Vietnam). The results imply the

recovery of the markets after the crisis. Again, the market returns series appears to be non-normal and not normally distributed over the period due to their high values of kurtosis and Jacque–Bera statistics.

To address the issues of market correlation, Table 4.7 below provides the correlation matrix of equity-market levels. Over the entire period, the correlations span from 0.27 (Thailand–Japan) to 0.97 (Singapore–Hong Kong). Among the markets, Japan displays relatively low correlations with the other markets except for its correlation with the US (0.91). This can be explained by different levels of market developments between the Japanese and the other markets in the sample. The results provide evidence of strong correlations between several pairs of market levels, such as Singapore–Hong Kong (0.97), Korea–Malaysia (0.95), Singapore–Malaysia (0.93) and Singapore–Taiwan (0.93), which may be due to the mutual interdependence of these economies.

Partitioning the sample into the pre- and post-crisis periods, we observe the correlations over the sub-periods. As can be seen in the table, the correlations are higher over the crisis periods compared to the pre- and post-crisis periods, suggesting strong co-movement among the markets during the turbulent period. Among the markets, the highest correlation exists between Hong Kong and Singapore (0.96). This could be explained by the close trade linkages between these two markets. An interesting point is that almost all correlations increase during the period of crisis, particularly the correlations between both Thailand and Vietnam and the other markets, highlighting the influence of the GFC on these markets. In addition, it is notable that the correlation coefficients between all market pairs vary considerably in the post-crisis period relative to the pre-crisis period (that is, some correlation coefficients increase while others decrease). These findings suggest different degrees of influence of the GFC on the markets after the crisis. Moreover, during the post-crisis period, almost all the correlations between Japan and other markets decline considerably, perhaps implying a slower recovery of Japan’s economy compared to the other markets.

Table 4.7: Correlation coefficient matrix of equity-market levels

Advanced markets							Emerging markets		
Entire period (28/7/2000–31/12/2010)									
	HK	JP	KR	SG	TW	US	ML	TL	VN
HK	1	0.49	0.87	0.97	0.89	0.62	0.91	0.69	0.81
JP		1	0.29	0.57	0.55	0.91	0.28	0.27	0.50
KR			1	0.89	0.82	0.35	0.95	0.85	0.79
SG				1	0.93	0.68	0.93	0.76	0.83
TW					1	0.67	0.87	0.77	0.68
US						1	0.42	0.36	0.52
ML							1	0.84	0.78
TL								1	0.60
VN									1
Pre-crisis period (28/7/2000–30/8/2008)									
	HK	JP	KR	SG	TW	US	ML	TL	VN
L_HK	1	0.82	0.84	0.97	0.90	0.89	0.89	0.64	0.80
L_JP		1	0.67	0.85	0.76	0.92	0.67	0.44	0.72
L_KR			1	0.90	0.87	0.65	0.94	0.86	0.79
L_SG				1	0.93	0.88	0.94	0.71	0.83
L_TW					1	0.80	0.90	0.73	0.69
L_US						1	0.71	0.44	0.70
L_ML							1	0.83	0.79
L_TL								1	0.57
L_VN									1
Crisis period (1/9/2008–28/2/2009)									
	HK	JP	KR	SG	TW	US	ML	TL	VN
L_HK	1	0.96	0.91	0.96	0.95	0.93	0.89	0.93	0.86
L_JP		1	0.88	0.97	0.94	0.96	0.90	0.94	0.92
L_KR			1	0.92	0.90	0.84	0.91	0.93	0.77
L_SG				1	0.97	0.96	0.95	0.97	0.93
L_TW					1	0.94	0.95	0.96	0.90
L_US						1	0.86	0.91	0.93
L_ML							1	0.97	0.86
L_TL								1	0.86
L_VN									1
Post-crisis period (2/3/2009 to 31/12/2010)									
	HK	JP	KR	SG	TW	US	ML	TL	VN
HK	1	0.71	0.92	0.96	0.96	0.93	0.92	0.88	0.81
JP		1	0.58	0.67	0.69	0.71	0.53	0.46	0.81
KR			1	0.96	0.95	0.95	0.97	0.97	0.64
SG				1	0.97	0.96	0.97	0.95	0.76
TW					1	0.96	0.95	0.91	0.74
US						1	0.95	0.91	0.73
ML							1	0.98	0.64
TL								1	0.58
VN									1

Table 4.8 below presents the correlation matrix for the equity-market returns. Vietnamese equity-market returns display low correlations with other market returns over the pre-crisis period (0.00–0.07), but increase considerably over the crisis (0.22–0.53) and post-crisis periods (0.09–0.33). The results imply stronger relationships between the Vietnamese and other markets under observation over the vulnerable periods. It is notable that both the US and Japan reveal the highest correlations with Vietnam over the sub-periods. However, there is a switching role between the two markets: during the pre-crisis period, Vietnam is more correlated with Japan, but during the crisis and post-crisis periods, the highest correlation is found between Vietnam and the US.

Another interesting point is that during the pre- and post-crisis periods, the US exhibits higher correlations with the advanced markets than the emerging markets; however, during the crisis period, the correlations between the emerging and US equity-market returns increase significantly, ranging from 0.26 (Thailand–the US) to 0.53 (Vietnam–US). In addition, it is noteworthy that although the correlations among the markets change over the sub-periods, the table illustrates higher interactions among the markets over the post-crisis period compared to the pre-crisis period, emphasising the impacts of the GFC on the market correlations.

Overall, the preliminary results show high volatilities in both market levels and returns for the Vietnamese equity market compared to those of other markets. The relatively low correlations between the Vietnamese and other markets may be explained by the impacts of the strict regulations imposed on the Vietnamese equity market during the crisis and post-crisis periods. In addition, the higher correlations among the examined markets support their stronger interactions after the crisis.

Table 4.8: Correlation coefficient matrix of equity-market returns

Advanced markets							Emerging markets		
Entire period (28/7/2000–31/12/2010)									
	HK	JP	KR	SG	TW	US	ML	TL	VN
HK	1	0.59	0.60	0.70	0.47	0.40	0.42	0.45	0.08
JP		1	0.59	0.53	0.44	0.49	0.36	0.35	0.16
KR			1	0.58	0.55	0.34	0.36	0.38	0.08
SG				1	0.47	0.34	0.48	0.47	0.06
TW					1	0.33	0.34	0.33	0.07
US						1	0.31	0.22	0.18
ML							1	0.38	0.07
TL								1	0.07
VN									1
Pre-crisis period (28/7/2000–30/8/2008)									
	HK	JP	KR	SG	TW	US	ML	TL	VN
HK	1	0.54	0.57	0.66	0.42	0.42	0.39	0.35	0.01
JP		1	0.55	0.50	0.38	0.39	0.31	0.27	0.07
KR			1	0.54	0.50	0.35	0.31	0.33	0.02
SG				1	0.43	0.37	0.44	0.39	0.00
TW					1	0.31	0.28	0.28	0.02
US						1	0.29	0.20	0.04
ML							1	0.33	0.01
TL								1	0.01
VN									1
Crisis period (1/9/2008–28/2/2009)									
	HK	JP	KR	SG	TW	US	ML	TL	VN
HK	1	0.68	0.73	0.77	0.62	0.35	0.54	0.69	0.22
JP		1	0.71	0.60	0.63	0.64	0.56	0.56	0.45
KR			1	0.75	0.72	0.34	0.61	0.54	0.24
SG				1	0.58	0.29	0.67	0.69	0.20
TW					1	0.43	0.60	0.50	0.30
US						1	0.38	0.26	0.53
ML							1	0.59	0.36
TL								1	0.35
VN									1
Post-crisis period (2/3/2009 to 31/12/2010)									
	HK	JP	KR	SG	TW	US	ML	TL	VN
HK	1	0.59	0.60	0.77	0.61	0.40	0.55	0.56	0.19
JP		1	0.66	0.52	0.56	0.57	0.47	0.38	0.23
KR			1	0.52	0.65	0.35	0.48	0.41	0.19
SG				1	0.61	0.33	0.57	0.56	0.14
TW					1	0.37	0.50	0.38	0.17
US						1	0.38	0.21	0.33
ML							1	0.44	0.17
TL								1	0.09
VN									1

4.2.3 Unit root tests

Unit roots tests are employed to examine levels of stationarity of the selected markets under observation. The tests are considered a necessary condition before examining the co-integration tests in order to ensure that the equity-market order of integration is the same. In this thesis, two groups of unit roots tests are performed. The first examines the stationarity of markets without considering structural breaks, while the second takes into account structural breaks caused by the GFC.

4.2.3.1 Unit root tests without structural breaks

Two common unit root tests that do not take structural breaks into consideration are the Augmented Dickey Fuller (ADF) test and the Phillips–Perron (PP) test. The ADF test (Dickey & Fuller 1979) is proposed to avoid errors of autocorrelation of a white noise factor ϵ_t by using p lags of the dependent variable, while the PP test (Phillips & Perron 1988) allows for a weakly dependent and heterogeneous distribution of error disturbances. Both of these tests examine the unit root of variables as given in equation 4.3 below:

$$y_t = a_0 + \gamma y_{t-1} + \sum_{i=2}^p \beta_i y_{t-1+i} + \epsilon_t \quad [4.3]$$

where $\gamma = -(1 - \sum_{i=1}^p \alpha_i)$, $\beta_i = \sum_{j=1}^p \alpha_j$ and y_t represents the market levels used in the thesis, p is a lag length, a_0 is the intercept, γ is the coefficient, β_i is the parameter of the lagged first difference of y_t and ϵ_t is the error term. The optimal lag length selection in the model is the lowest value of the Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC). To ensure that the co-integration tests are performed among variables at the same order of integration, unit root tests are also conducted for the first difference of the variables as given in equation 4.4:

$$\Delta^2 y_t = a_0 + \sum_{i=1}^p \gamma_i \Delta^2 y_{t-1} + \epsilon_t \quad [4.4]$$

The null hypothesis of these tests is $\gamma_i = 0$, meaning that variables are unit root, defined as non-stationarity, while the alternative hypothesis supports a stationary variable. The critical values for the test are derived from the simulations experiments undertaken by MacKinnon

(1991). The null hypothesis of the unit root may be rejected if the t-statistic is smaller than the critical value at a 95 per cent level.

In this thesis, both the ADF and PP tests are employed to examine the stationarity of market levels and market returns of the selected equity markets to ensure robustness. Due to different levels of economic development among the selected markets, the tests are specified in both the model with intercept and the model with intercept and trend. In the case of inconsistent results between these models, visual inspections of the graphs of individual market movement are performed to confirm the most appropriate results.

The unit root tests are performed over the entire period and over the sub-periods. If any individual market in the sample rejects the null hypothesis of the unit root in the market levels but cannot reject it in the market returns, its market level series can be used for a co-integration test at one order, $I(1)$. The specifications of the testing equations are equations with intercept and equations with trend and intercept for both the market levels and market returns in the sample. Results of the ADF and PP unit root tests for the specification with intercept and trend are shown in Table 4.9 below, while those for the specification with intercept are presented in Appendix 4.1.

Table 4.9: Results of the unit root tests of market levels and market returns

	Advanced markets						Emerging markets		
	HK	JP	KR	SG	TW	US	ML	TL	VN
A. Unit root tests of the market levels									
Entire period									
ADF	-2.70	-1.95	-2.72	-2.04	-3.14	-2.07	-2.49	1.60	-1.66
Lag	0	0	0	0	0	2	1	0	4
PP	-2.7	-1.82	-2.74	-2.11	-3.20	-2.14	-2.56	1.70	-1.86
Lag	7	11	1	9	2	4	14	6	26
Pre-crisis period									
ADF	-2.82	-2.34	-3.08	-2.39	-3.99*	-2.53	-3.08	1.30	-1.43
Lag	0	0	0	0	0	1	3	0	5
PP	-2.81	-2.30	-3.10	-2.41	-4.06*	-2.44	-2.96	1.32	-1.55
Lag	2	4	1	7	8	19	11	1	22
Post-crisis period									
ADF	-2.71	-3.02	-3.85	-2.71	-3.14	-2.98	-2.10	2.34	-3.00
Lag	0	0	0	0	0	0	1	0	1
PP	-2.68	-2.99	-3.83	-2.72	-3.20	-2.98	-2.08	2.32	-3.00
Lag	6	3	11	2	2	0	4	1	5
B. Unit root tests of the market returns									
Entire period									
ADF	-53.90*	-39.50*	-51.48*	-51.30*	50.20*	41.50*	-44.50*	-34.00*	21.30*
Lag	0	1	0	0	0	1	0	1	2
PP	-53.90*	-53.10*	-51.48*	-51.30*	50.20*	57.50*	-44.70*	-51.70*	44.40*
Lag	7	12	4	8	3	5	9	5	23
Pre-crisis period									
ADF	-47.20*	-47.20*	-45.20*	-45.40*	44.50*	48.70*	-23.20*	-30.30*	16.00*
Lag	0	0	0	0	0	0	2	1	4
PP	-47.20*	-47.20*	-45.30*	-45.40*	44.50*	49.10*	-39.20*	-45.80*	39.90*
Lag	3	4	6	7	11	18	8	1	19
Post-crisis period									
ADF	-22.20*	-22.50*	-22*	-21.20*	20.30*	23.60*	-18.90*	-22.50*	17.50*
Lag	0	0	0	0	0	0	0	0	0
PP	-22.20*	-22.50*	-22.10*	-21.20*	20.30*	23.60*	-18.90*	-22.50*	17.50*
Lag	5	3	10	2	4	1	1	0	2

Notes: The critical values for both the ADF and PP tests are -3.96, -3.41 and -3.12 at 1 per cent, 5 per cent and 10 per cent respectively. An intercept and trend are included in the test equation for both tests. * denotes the rejection of the null hypothesis at 1 per cent level of significance.

In general, the results indicate evidence in favour of the existence of the unit root in both ADF and PP tests in the market levels of almost all equity markets over the entire period and sub-periods, since the null hypothesis is not rejected at the 1 per cent level of significance except for the case of Taiwan over the pre-crisis period. Similar empirical estimations in the stationarity of the selected market levels and returns with intercept are also found, except for the Vietnam market level over the post-crisis period (Appendix 4.1). By visual inspection of the graphs for the two equity-market levels (see Figure 4.1 above, panel A) we observe that Taiwan's graph is more appropriated for the model with intercept while Vietnam's graph is supported for the model with intercept and trend. These results are in line with the findings of Huyghebaert and Wang (2010) and Chan, Leong and Felmingham (2003) on the contradictory evidence of the stationarity of Taiwan's equity-market levels in the model with intercept and the model with intercept and trend. Finally, they include an intercept with no trend in the test. Our findings are generally consistent with previous results by Yang and Lim (2004), whose findings support the stationarity of market returns of Hong Kong, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand. Therefore, we may conclude that all the individual markets in the study have a unit root or are non-stationary in the market levels but stationary in the market returns. As such, all the equity-market levels can be used to investigate the co-integration of order one, $I(1)$.

4.2.3.2 Unit root tests in the presence of structural breaks

Having already identified breaks in the entire time series caused by the impacts of the GFC, unit root tests in the presence of structural breaks are also examined. A unit root test in the presence of structural breaks is proposed by Zivot and Andrews (2002). As stated by Soheli Azad (2009), the test avoids the bias towards non-rejection of the unit root null hypothesis while the series are stationary and subject to a structural-break date. In this thesis, two versions of the test are employed to examine the stationarity of the selected market indices, including a model allowing for breaks in intercept, and a model allowing for breaks in trend and intercept, as follows:

(1) A break with intercept

$$y_t = a_0 + \gamma y_{t-1} + jDU_t + \sum_{i=2}^p \beta_i y_{t-1+i} + \epsilon_t \quad [4.5]$$

(2) A break with intercept and trend

$$y_t = a_0 + \gamma y_{t-1} + jDU_t + zDT_t + \sum_{i=2}^p \beta_i y_{t-1+i} + \epsilon_t \quad [4.6]$$

where y_{1t} and y_{2t} are market levels/returns that are of $I(1)$. DU_t is a dummy variable capturing for an intercept change and DT_t corresponds for a trend change occurring at time TB , which searches over the range of the sample $(0.15T, 0.85T)$. DU_t and DT_t are determined by:

$$DU_t = \begin{cases} 0 & \text{if } t \leq TB \\ 1 & \text{if } t > TB \end{cases} \quad [4.7]$$

and

$$DT_t = \begin{cases} 0 & \text{if } t \leq TB \\ t - TB & \text{if } t > TB \end{cases} \quad [4.8]$$

The breakpoint is selected at time TB if the t-statistic of γ is minimised. The null hypothesis of the test is non-stationarity of the market levels y_t , $I(1)$ against the alternative hypothesis of stationarity of market levels, $I(0)$. The critical value for the test is proposed by Zivot and Andrews (2002).

Given that the time series data of the nine market levels examined in the thesis may include structural breaks due to shocks or depressions resulting from the GFC, we examine the stationarity of the logarithm of market indices taking into account the presence of structural breaks. The results in Table 4.10 below reveal that a breaking date on the logarithm of the market indices spans 25/08/2005–22/09/2008. An interesting feature is that only the Vietnamese equity market has a breakpoint occurring before 2007. This result may be explained by a dramatic boom in Vietnam's equity-market index over the period 2005–early 2007, when it experienced significant growth in FDI capital and performed successfully the initial public offering process (World Bank 2007). In addition, all our findings support an argument of non-stationarity or unit root of the selected markets at the market levels because the values of t-statistics are smaller than the critical values for the t-statistics suggested by Zivot and Andrews (2002).

Table 4.10: Results of the unit root tests in the presence of structural breaks of the selected market levels, 2000–2010

	Model with intercept			Model with intercept and trend		
	Lag	Break date	t-stat.	Lag	Break date	t-stat.
HK	1	03/06/2008	−3.4	1	04/08/2008	−3.67
JP	4	19/06/2008	−3.55	4	12/08/2008	−3.36
KR	0	09/06/2008	−4.46	0	09/06/2008	−4.47
SG	0	20/05/2008	−3.23	0	25/07/2008	−3.72
TW	0	20/05/2008	−4.38	0	09/06/2008	−5.09
US	3	06/06/2008	−3.47	3	22/09/2008	−4.07
ML	3	20/02/2008	−3.76	3	02/06/2008	−4.41
TL	6	22/05/2008	−3.09	6	22/05/2008	−3.76
VN	5	25/08/2005	−3.03	5	06/02/2006	−3.22

Notes: The critical values for t-statistic of the Zivot and Andrews test are −5.43 and −4.8 at 1 per cent and 5 per cent respectively. * denotes rejections of the hypothesis at the 5 per cent level.

According to the results of the three unit root tests discussed above, it may be concluded that the selected equity-market indices are non-stationary at the market levels but stationary at the market returns during the entire period and sub-periods. Therefore, the nine equity markets are suitable for employing the co-integrating tests of order one, $I(0)$, between pairs of markets as well as among groups of equity markets.

4.3 Research methodology

4.3.1 Co-integration

Co-integration implies a long-run co-movement between two data sets (in our case, equity markets). Previous studies of co-integration among equity markets are generally divided into two groups: relationships between two markets and relationships among a series of markets. Hence in the thesis, to answer the primary research question regarding the existence of a co-integration relationship between and among the Vietnamese equity market and global equity markets, two additional questions are developed as follows:

Question 1: *Is there a co-integration relationship between and among the Vietnamese equity market and other selected equity markets?*

Question 2: *Given the presence of co-integration relationships between and among the Vietnamese equity market and other selected equity markets, have these relationships changed over the course of the GFC?*

In the literature, the co-integration testing models can be classified into two groups. The first testing group is known as bivariate co-integration tests while the other is multivariate co-integration tests. In addition, the GFC is taken into account in the thesis, so the co-integration allowing for structural breaks is also examined. In short, three co-integration tests are performed in the thesis including bivariate co-integration tests based on residuals developed by Engle and Granger (1987); bivariate co-integration relationships allowing for structural breaks suggested by Gregory and Hansen (1996); and the co-integration test based on VAR model proposed by Johansen (1988) and Johansen and Juselius (1990). All three co-integration tests are conducted to investigate the long-run linkages between and among the Vietnamese and other selected markets in the sample. Stata 12 is used to perform these tests.

4.3.1.1 Co-integration based on residuals

As stated by Engle and Granger (1987), equity-market indices may diversify in the short run but link together in the long run. Thus, correlation coefficients between the indices cannot measure effectively a long-run movement among the markets. The authors suggest a method of testing for co-integration based on residuals of ordinary least square regression.

The ordinary least square regression model between two non-stationary equity-market levels is performed to generate residuals or error terms as per equation 4.9:

$$y_t = \beta_1 + \beta_2 x_{2t} + \beta_3 x_{3t} + \dots + \beta_k x_{kt} + u_t \quad [4.9]$$

where y_t and x_{it} represent market levels, β_k is the parameter and u_t is the error term.

We employ this model to examine the long-run linkages between the Vietnamese and selected markets as well as between the pairs of other markets. The stationary tests are employed for the above estimated residuals by using the ADF and PP unit root tests. Two equity-market levels are found to be co-integrated in the long-run relationship if error term u_t is stationary $I(0)$ (that is, the t-statistic of the coefficient is greater than a critical value); whereas they are not co-integrated if u_t is non-stationary $I(1)$ (that is, the t-statistic of the coefficient is smaller than a critical value). A set of critical values is calculated by Engle and Granger (1987).

4.3.1.2 Co-integration in the presence of structural breaks

As stated by Gregory and Hansen (1996), co-integration tests based on residuals are not appropriate if a linear combination of two variables has a break at one unknown point. The authors suggest a co-integration test allowing for structural breaks to examine the long-run relationship between two variables. A break date is found by employing the test suggested by Zivot and Andrews (2002), who modify the ADF specification by adding a dummy variable in the co-integration regression. Then, based on the study of Zivot and Andrews (2002), the relationship between markets, taking into account the existence of structural breaks in time series data, is examined.

Given that the GFC may cause breaks in the time series data of the Vietnamese and selected market levels, this thesis also uses co-integration tests allowing for breaks to further investigate the impacts of the GFC on the linkages between the Vietnamese and other markets as well as pairs of markets in the sample over the pre and post-crisis period. Two models are proposed to investigate the co-integration with regime shifts as follows:

(1) A break with intercept

$$y_t = a_0 + \beta_t x_t + jDU_t + m_t \quad [4.10]$$

(2) A break with intercept and trend

$$y_t = a_0 + jDU_t + \beta_t x_t + \beta_t t + \gamma x_t DT_t + m_t \quad [4.11]$$

where y_t and x_t are equity-market levels in the sample, and DU_t and DT_t are dummy variables on possible breaks that may occur in data sets.

The tests follow two steps: firstly, the residual m_t of the equation is estimated and then ADF tests for checking stationary of m_t are examined. The null hypothesis is that if m_t of $I(0)$, a co-integrating relationship exists between two markets, otherwise the alternative hypothesis for non-co-integration exists with the presence of a structural break.

4.3.1.3 Co-integration based on the VAR model

In spite of its simplicity, there are some problems associated with the Engle and Granger test. As indicated by Brook (2002), the purpose of the test is to find at most one co-integrating

relationship, but it fails to determine whether other co-integrating relationships exist. Therefore, we employ a vector autoregressive (VAR) model to further examine co-integrating relationships among groups of markets. The technique is suggested by Johansen (1988) and Johansen and Juselius (1990), with assumptions of white-noise errors. Market levels of selected markets in the sample are used as a dependent variable in turn to examine co-integration with other markets, as follows:

$$z_t = c + A_1 z_{t-1} + \dots + A_p z_{t-p} + \mu_t \quad [4.12]$$

where z_t is a $(n \times 1)$ vector of market levels that are integrated of order one or $I(0)$, p is the lag order of the VAR model and μ_t is a white noise.

The lag-length selection of the VAR model is important for the Granger causality tests to avoid problems with serial correlation. Several criteria are suggested to determine the lag length in VAR model, such as the AIC (Akaike 1974) and the SIC (Schwarz 1978), the maximum likelihood ratio (Sims 1988) and the Hannan–Quinn criterion (Hannan & Quinn 1979) to determine a number of appropriate lag lengths. Following the studies by Daly (2003) and Au Yong, Gan and Treepongkaruna (2004), we select the lag length by choosing the lowest of the AIC and SIC.

Two test statistics are proposed to examine the long-run linkages, namely the trace test and the maximum-Eigenvalue test as shown in equations 4.13 and 4.14 respectively:

$$\lambda_{\text{trace}} = -T \sum_{j=r+1}^k \ln(1 - \lambda_j) \quad [4.13]$$

$$\lambda_{\text{max}} = -T \ln(1 - \lambda_j) \quad [4.14]$$

where T is the sample size and λ_j are the estimated values of the characteristic roots.

In the trace test, the null hypothesis of r co-integration vectors is against the alternative hypothesis of n co-integration vectors among the market levels, whereas in the maximum-Eigenvalue test, the null hypothesis of r co-integration vectors is against the alternative hypothesis of $r+1$ co-integration vectors may be existed. The t -statistics obtained from the tests are then compared to the critical values suggested by Johansen and Juselius (1990).

The impacts of the GFC on the long-run linkages across a group of market are investigated by conducting the above tests over the entire period and sub-periods.

4.3.2 Causal relationships among equity markets

In the thesis, causal relationships are also known as lead-lag relationships, and give regard to the predictability of one variable from its own past values and past values of other variables. This implies the existence of interdependence between the markets. The relationship is worth researching because it reveals a dynamic relationship between and among the Vietnamese and other market returns in a short-run linkage.

To examine the causal relationships between and among the Vietnamese and global equity markets, a further two secondary research questions are developed:

***Question 3:** Is there a causal relationship between and among the Vietnamese equity market and other selected equity markets?*

***Question 4:** Given the presence of a causal relationship between and among the Vietnamese equity market and other selected equity markets, has the nature of this relationship changed over the course of the GFC?*

We explore the short-run relationship among the markets by employing two common approaches on causality. The first is a pair-wise Granger causality test to examine the linkages between two markets, while the second is a multivariate Granger causality test based on VAR to investigate the linkages among a group of markets. Additionally, further tests based on the VAR model are carried out, including the impulse response and variance decomposition. These tests are conducted using EViews 7.

4.3.2.1 Pair-wise Granger causality test

A pair-wise Granger causality test is used to examine a lead-lag linkage between returns in pairs of markets. As proposed by Granger (1969), the test measures how much the movement of one variable can be explained by its own past values as well as lagged values of other variables. Therefore, two markets' returns are said to be Granger-caused if the lagged returns of one market can be used to predict the current returns of the other market. The tests are estimated as follows:

$$Y_t = a + b_i Y_{t-i} + c_i X_{t-i} + u_t \quad [4.15]$$

$$X_t = a' + b'_i Y_{t-i} + c'_i X_{t-i} + u'_t \quad [4.16]$$

where a, a' are constant, b_i, b'_i, c_i, c'_i are coefficients, Y_t and X_t are market returns of the selected equity markets, u_t and u'_t are error terms and i is lag length. The null hypothesis is that the joint significance of c_i and c'_i is zero, which means that the two market-returns series under observation do not Granger-cause. Test significance is based on the value of the F-statistic under the null hypothesis that X_t does not Granger-cause Y_t and vice versa.

The Granger causality test reveals not only the existence of causal linkages between each pair of market returns, but also the direction of the linkages.¹⁶ The impacts of the GFC on the causal linkages between the Vietnamese and other markets as well as the pairs of other market returns are examined by performing the tests over the pre- and post-crisis periods. If empirical findings change over the periods, we will make a conclusion in favour of the impacts of the GFC on the short-run linkages between two markets.

4.3.2.2 Multivariate Granger causality test based on the VAR model

Together with the pair-wise Granger causality test, this thesis uses the multivariate Granger causality test based on the VAR model to examine the Granger cause among the equity-market returns in a dynamic structure. Specifically, the test treats market returns in a system as a function of lagged values of all returns in the system (Chen, Firth and Rui 2002; Chung-Hua, Chien-Fu and Li-Hsueh 2007; Fayyad and Daly 2011). As suggested by Sims (1980), the model is given as follows:

$$y_t = c + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \dots + \beta_p y_{t-p} + \varepsilon_t \quad [4.17]$$

¹⁶ A feedback (or bi-directional) relationship implies two causal relationships while a mono-directional relationship suggests a one-way directional relationship between two markets.

where y_t is an $(n \times 1)$ vector of market returns, c is an $(n \times 1)$ vector of constants, β_p is an $(n \times n)$ matrix of coefficients, ε_t is a multivariate white-noise process and p is a number of lag lengths.

As stated by Granger (1986), there is a relationship between co-integration and causation. Thus, depending on the results of co-integration relationships, one of three models is used to examine causality among the equity markets. The models, known as the VAR models of market levels, are described in turn below.

Model 1: If the market levels of selected markets are stationary, or $I(0)$, and not co-integrated, the following regression can be applied:

$$y_{1t} = a_0 + \sum_{i=1}^k \alpha_{1i} y_{1t-i} + \sum_{i=1}^k \alpha_{2i} y_{2t-i} + \varepsilon_{1t} \quad [4.18]$$

$$y_{2t} = \beta_0 + \sum_{i=1}^k \beta_{1i} y_{1t-i} + \sum_{i=1}^k \beta_{2i} y_{2t-i} + \varepsilon_{2t} \quad [4.19]$$

where y_{1t} and y_{2t} are denoted as market levels and ε_{1t} ε_{2t} are assumed to be serially uncorrelated, with zero mean and finite co-variance matrix.

Model 2: If the market levels of selected markets are non-stationary, or $I(1)$, and not co-integrated, their first differences are stationary, and the VAR model of market returns can be applied to the causality test in the following regression form:

$$\Delta y_{1t} = a_0 + \sum_{i=1}^k \alpha_{1i} \Delta y_{1t-i} + \sum_{i=1}^k \alpha_{2i} \Delta y_{2t-i} + \varepsilon_{1t} \quad [4.20]$$

$$\Delta y_{2t} = \beta_0 + \sum_{i=1}^k \beta_{1i} \Delta y_{1t-i} + \sum_{i=1}^k \beta_{2i} \Delta y_{2t-i} + \varepsilon_{2t} \quad [4.21]$$

where Δy_{1t} and Δy_{2t} denote the first difference of market levels of two different countries and ε_{1t} ε_{2t} are assumed to be serially uncorrelated, with zero mean and finite co-variance matrix.

Model 3: If the market levels of selected equity markets are found to be non-stationary, or $I(1)$ and co-integrated, the Granger causality models are adjusted to the presence of an error correction term (ECT) derived from the co-integration relationship. This causality model,

often known as the vector error correction (VEC) model, is presented in the following equations:

$$\Delta y_{1t} = a_0 + \sum_{i=1}^k \alpha_{1i} \Delta y_{1t-i} + \sum_{i=1}^k \alpha_{2i} \Delta y_{2t-i} + \phi_{y_{2t}} ECT_{y_{1,t-i}} + \varepsilon_{1t} \quad [4.22]$$

$$\Delta y_{2t} = \beta_0 + \sum_{i=1}^k \beta_{1i} \Delta y_{1t-i} + \sum_{i=1}^k \beta_{2i} \Delta y_{2t-i} + \phi_{y_{1t}} ECT_{y_{2,t-i}} + \varepsilon_{2t} \quad [4.23]$$

where $\phi_{y_{2t}}$ and $\phi_{y_{1t}}$ are the parameters of a co-integrating vector explaining the effects of the long-run relationship on variables. In other words, the model shows the differentiation between causality based on short-run and long-run relationships.

If the null hypothesis $H_0: \alpha_{21} = \alpha_{22} = \dots = \alpha_{2k} = 0$ is retained, it suggests that y_{2t} does not Granger-cause y_{1t} . Conversely, if the null hypothesis $H_0: \beta_{21} = \beta_{22} = \dots = \beta_{2k} = 0$ is rejected, it implies that y_{1t} does not Granger-cause y_{2t} .

In this thesis, the multivariate Granger causality tests are examined over the pre- and post-crisis periods to investigate the impacts of the GFC on the causality linkages among the selected equity markets. In addition, the lag-length structure in the test equations is based on the lowest values of AIC and SIC. The lag lengths are then checked for serial correlation by using the Lagrange multiplier as employed by Gupta and Guidi (2012). It is noteworthy that as this thesis examines causality among nine equity markets, we also take into account the differences in trading zones among the markets by lagging the US market returns compared to the other market-returns series in the sample.

4.3.2.3 VAR analysis

Two further tests based on the VAR structure are performed in this thesis to examine the interdependence of variances among the markets. The first model is variance decomposition, used to examine dynamic effects of one market's variance in relation to variances of other markets. In other words, the model examines whether variances of one market can be explained by variances of other endogenous markets in the VAR structure. For the purposes of this test, the variance decomposition is displayed in five-day periods.

The second model is an impulse response function illustrating the effects of an exogenous shock to variances in the VAR structure. This test is used to trace the effects of a one-time shock of each market return to all endogenous market returns in the structure. The study employs the generalised impulse response function as proposed by Pesaran and Shin (1998) to eliminate the effects of the VAR ordering in the system.

It is notable that, depending on the results of the multivariate co-integration tests, the VAR analysis in this thesis can employ the VAR or the VEC model. Specifically, if market levels are co-integrated, the VEC model of market levels is employed; however, if market levels are not co-integrated, the VAR model of market returns is used.¹⁷

4.3.3 Contagion effects among the equity markets

While the above models take into account the long-run and short-run linkages between and among the markets, this section discusses other models examining the transmission of the shock caused by the GFC to the Vietnamese and other selected markets. This transmission is known as a contagion effect. In the thesis, the question as to whether the GFC transmitted a shock to the Vietnamese market and to other markets is investigated based on the following question:

***Question 5:** Was a shock transmitted from the GFC to the Vietnamese equity market and other selected equity markets?*

In the existing literature, several empirical models are used to identify the existence of contagion effects; however, these models are based on different definitions of contagion.

In this thesis, the contagion effect is defined as a significant increase in cross-market linkages after a shock or crisis, as indicated in the equity-market linkage section in Chapter 2. As such, although there are a range of contagion testing models in the literature, such as correlations (Bollerslev 1990; Engle 2002; Forbes and Rigobon 2002), breaks in regression models (Favero and Giavazzi 2002; Dungey et al. 2005) and factor models of returns (Bekaert, Harvey and Ng 2005; Corsetti, Pericoli and Sbracia 2005; Dungey et al. 2007), this thesis examines contagion tests with regard to correlation coefficients between two markets as suggested by Forbes and Rigobon (2002). However, as discussed by Forbes and Rigobon

¹⁷See Huyghebaert and Wang (2010) for a further example.

(2002), correlation coefficients are time-varying during periods of crises because cross-market correlations may be biased by increases in market volatility. Hence, this thesis employs two methods of time-varying correlations: the constant conditional correlation (CCC) model (Bollerslev 1990) and the dynamic conditional correlation (DCC) model (Engle 2002). These methods are based on the dynamic of time-varying correlations tracking from MGARCH models of volatility. MATLAB is used to perform these tests.

4.3.3.1 Constant conditional correlation test

To capture the time-varying variances of market returns, the univariate GARCH model (1, 1) (Bollerslev 1986) is employed to estimate conditional return and volatility of each market as given in the following equations:

$$\text{Return equation: } r_t = \mu + \gamma_1 r_{t-1} + \varepsilon \quad [4.24]$$

$$\text{Volatility equation: } h_t = w_i + \alpha \varepsilon_{i,t-1}^2 + \beta h_{it-1} \quad [4.25]$$

where $i = 1, 2, \dots, m$ indicates the i^{th} equation in the model and r_t is a linear regression of the individual market returns equation, including a constant term μ and the error term $\varepsilon_{i,t-1}$ of the i^{th} equation. The conditional variance, $h_{i,t}$, is a function of lagged values of square residuals $\varepsilon_{i,t-1}^2$, α captures innovations of its past square residuals, and β presents influences of lagged values of its conditional variance. w_i is a constant term of the volatility equation. The necessary conditions to the equation 4.25 are: both α and β are non-negative and $\alpha + \beta < 1$.

Constant conditional correlation tests use nonlinear combinations of GARCH models to represent conditional co-variances. The CCC (ρ_t) is decomposed into a matrix of conditional variance (h_{ij}) and a diagonal matrix of the square root of the conditional variances ($h_{ii,t}^{-1/2}$) by using the following model:

$$\rho_t = h_{ii,t}^{-1/2} h_{ij,t} h_{jj,t}^{-1/2} \quad [4.26]$$

In this thesis, the CCCs are estimated between pairs of markets for the entire period and sub-periods. If the CCCs significantly increase during the crisis and post-crisis period compared to

the pre-crisis period, we can conclude that the contagion effect exists and is caused by the GFC between the markets.

4.3.3.2 Dynamic conditional correlation test

Although the CCC model measures the conditional correlations of market volatilities; the correlations are static over the period of study. We further employ the DCC model to allow for time-varying conditional correlation. This model is also based on the univariate GARCH (1, 1) model of market returns of individual markets to estimate their conditional variances σ_t . Each univariate error process is then transformed to the standardised residuals by:

$$\delta_{t-1} = \frac{\varepsilon}{\sqrt{h_t}} \quad [4.27]$$

The conditional variance is assumed to be time-varying by following the GARCH (1, 1) model given by:

$$\sigma_t = (1 - \theta_1 - \theta_2)\bar{\sigma} + \theta_1\delta_{t-1}\delta'_{t-1} + \theta_2\sigma_{t-1} \quad [4.28]$$

where $\bar{\sigma}$ is the unconditional co-variance of the standardised residuals (δ_t) resulting from the univariate GARCH, and θ_1 and θ_2 are parameters. Both θ_1 and θ_2 must be positive and $\theta_1 + \theta_2 < 1$. In other words, the DCC model includes the two GARCH (1,1) processes of stock returns and standardised residuals. The DCC is decomposed into a matrix of conditional variance (σ_{ij}), and a diagonal matrix of the square root of the conditional variances ($\sigma_{ii,t}^{-1/2}$) is given below:

$$\rho_t = \sigma_{ii,t}^{-1/2} \sigma_{ij,t} \sigma_{jj,t}^{-1/2} \quad [4.29]$$

To measure the coefficients, Engle (2002) proposes maximising the likelihood function in the following equation:

$$L_t = -\frac{1}{2}\sum_{t=1}^T [n\log(2\pi) + \log|D_t|^2 + \varepsilon'_t D_t^{-2} \varepsilon_t] - \frac{1}{2}\sum_{t=1}^T [\log|R_t| + \varepsilon'_t R_t^{-1} \varepsilon_t - \varepsilon'_t \varepsilon_t] \quad [4.30]$$

Since the DCC will report graphs on time-varying correlations between any pairs of market returns over the entire period, we will take into account movements of the DCCs over the pre- and post-crisis periods to analyse transmissions of the crisis to the markets.

4.4 Chapter conclusion

This chapter provides a summary of a series of research methods used in this thesis to examine the linkages between and among Vietnam and its eight major partners including co-integration tests, causality tests and contagion tests. The effects of the GFC on these linkages are taken into account by applying the pre- and post-analysis technique.

Based on the structure of FDI flows in Vietnam in the last decade, eight countries (Hong Kong, Japan, Korea, Singapore, Taiwan, Malaysia, Thailand and the US) are selected and their equity-market linkages to the Vietnamese equity market are examined. All benchmark equity-market indices are collected from DataStream International over the period 28/7/2000–31/12/2010.

The preliminary results show increasing interactions among the markets during the crisis and post-crisis periods. Low correlations between the Vietnamese and other markets are found as a result of the strict regulations in monitoring and supervising the market imposed by the Vietnamese government. In addition, all the markets are not normally distributed in both market levels and returns.

Chapter 5: Empirical Estimations with Models

5.1 Overview

This chapter presents empirical results pertaining to the analysis of equity-market linkages between and among Vietnam and its eight major partners, Hong Kong, Japan, Korea, Singapore, Taiwan, the US, Malaysia and Thailand. Three testing models - co-integration, causality and contagion - are used to examine the bivariate and multivariate relationships among the nine equity markets in both the market levels and returns. The time-varying volatility of each equity markets' returns is taken into consideration in order to explore the transmission of shocks resulting from the GFC. The sequence of tests is as follows. Firstly, we test for long-run relationships between markets by performing co-integration tests for both bivariate and multivariate testing models. Next, causal relationships among the equity markets are examined by employing pair-wise and multivariate Granger causality tests. Finally, contagion effects using the CCC and DCC models between pairs of selected markets are examined. All tests are performed over the entire period, and over pre- and post-crisis periods, to discover the effects of the GFC on equity-market linkages between and among the Vietnamese and other equity markets under investigation.

The structure of this chapter is as follows. Section 5.2 presents empirical findings on co-integration relations. Section 5.3 illustrates empirical findings on causal relationships. Results of contagion are presented in section 5.4. Finally, section 5.5 concludes the chapter.

5.2 Co-integration among equity-market levels

This section investigates the long-run co-movement between and among the Vietnamese equity market and its major trading partners over the period 28 July 2000–31 December 2010. Three models are employed in this section: bivariate co-integration tests based on residuals, bivariate co-integration tests allowing for a structural break, and bivariate and multivariate co-integration tests based on the VAR model. The impacts of the GFC on the linkage are examined by comparing the empirical findings between the pre- and post-crisis periods.

5.2.1 Bivariate co-integration based on residual tests

Empirical findings with respect to bivariate co-integration tests between Vietnam and its major trading partners in the sample are presented in Table 5.1 below. In general, we find statistically significant evidence of co-integration relationships among the markets during the entire sample and pre-crisis period but little evidence of co-integration during the post-crisis period. Specifically, the Vietnamese equity market is found to co-move with the Hong Kong, Singaporean, Taiwanese and US equity markets during the entire period, and the Hong Kong, Japanese, Singaporean, Taiwanese and US equity markets during the pre-crisis period. In addition, only Japan exhibits long-run co-integration with Vietnam during the pre- and post-crisis periods. This could be due to a close relationship between the Vietnamese and Japanese equity markets because the two countries signed the Japan–Vietnam Investment Agreement in November 2003 to promote liberalisation and protection of investment. Interestingly, no evidence of long-run co-movement is found in the relationship between the Vietnamese equity market and the emerging equity markets during the entire sample period and sub-periods. The result is somewhat surprising as these countries are members of ASEAN, with the overall purpose of accelerating economic growth in the region. This notwithstanding, the finding is in line with previous studies on a lack of long-run co-movement between emerging markets (see Yang and Lim (2004); Daly (2003)).

The empirical results of the bivariate co-integrations between the pairs of other markets in the sample are provided in Table 5.2 below. Among the advanced markets, the Taiwanese equity market exhibits more evidence of co-integration than the other markets during the pre-crisis period. Some of our findings are in line with Leong and Felmingham (2003), who support the long-run relationship between several Asian equity markets such as Taiwan–Singapore and Korea–Taiwan. However, contrary to Leong and Felmingham (2003), our results show no evidence of co-movement between Japan–Taiwan and Japan–Singapore during the entire sample, and pre- and post-GFC periods. In addition, compared to Cheung, Fung and Tsai (2010), who support the co-movement between Japan–US during the period 1/2003–4/2009, our findings only report evidence of a long-run relationship between these markets during the pre-GFC period, and not during the post-GFC. These results suggest the impacts of the GFC on the long-run co-movements among global-equity markets.

Table 5.1: Results of bivariate co-integration based on residuals between the Vietnamese and selected market levels

	Entire period	Pre-crisis period	Post-crisis period
Advanced markets			
VN–HK	–4.05*	–3.82**	–2.26
HK–VN	–3.56*	–3.29***	–2.15
VN–JP	–2.92	–3.54**	–2.90
JP–VN	–2.78	–3.49**	–3.47**
VN–KR	–2.41	–2.29	–1.60
KR–VN	–1.67	–1.82	–1.10
VN–SG	–3.52**	–3.31***	–2.00
SG–VN	–2.95	–2.83	–1.41
VN–TW	–3.93*	–3.67**	–1.97
TW–VN	–3.58**	–3.72**	–1.72
VN–US	–3.21***	–3.59**	–1.84
US–VN	–3.07***	–3.58**	–1.26
Emerging markets			
VN–ML	–2.52	–2.70	–2.61
ML–VN	–1.58	–2.20	–0.36
VN–TL	–1.75	–1.37	–2.67

Notes: The specification of the equation is the ADF without trend and lag lengths are based on the SIC with a maximum lag of 25. *, ** and *** denote rejections of the hypothesis at the 1 per cent, 5 per cent and 10 per cent level respectively.

Table 5.2: Results of the bivariate co-integration between pairs of equity-market indices based on residuals

Entire period							Pre-crisis period						Post-crisis period				
HK	SG	TW	ML	VN			SG	TW	VN			TW	ML				
	-3.37**	-3.34**	-3.14***	-3.56*			-3.45**	-3.24***	-3.29***			-3.18***	-3.26***				
JP							US	VN			ML	TL	VN				
							-3.37**	-3.48**			-3.13***	-3.16***	-3.46**				
KR	TW	ML					TW	ML					ML	TL			
	-3.63*	-3.53*					'-4.02*	-3.1***			-5.1*	-5.47*					
SG	HK	TW	ML				HK	TW					TW	ML			
	-3.30***	-3.63*	-3.53*				-3.44**	-4.44*			-3.85**	-3.78*					
TW	HK	KR	SG	ML	TL	VN	HK	KR	SG	ML	TL	VN	HK	US	SG	TL	
	-3.78**	-3.88*	-5.05*	-4.36*	-4.15*	[-3.58***]	-3.67**	-4.35*	-4.79*	'-4.72*	-3.73*	-3.72*	-3.29***	-5.55*	-4.15*	-4.23*	
US	VN						JP	SG	VN			TW	ML	SG			
	-3.07***						-3.41**	-3.13***	-3.56**			-5.22*	-3.51**	-3.06***			
ML	KR	TW					KR	TW					KR	SG	TW	US	TL
	-3.35**	-3.91*					-3.21***	-4.36*			-4.58*	-3.26***	-4.04*	-3.19***	-3.22***]		
TL	TW						TW						KR	TW	ML		
	-4.17*						-3.74**						-4.93*	-3.12***	'-3.18***		
VN	HK	US	SG	TW			HK	US	JP	SG	TW						
	-4.01*	-3.20***	-3.52**	-3.93*			-3.82**	-3.59**	-3.54**	-3.31***	-3.67**						

Notes: The specification of the equation is ADF without trend and lag lengths are based on the SIC with a maximum lag of 25. *, ** and *** denote rejections of the null hypothesis at the 1 per cent, 5 per cent and 10 per cent level respectively.

Another interesting result is that during the post-crisis period, two emerging markets—the Malaysian and Thai equity markets—are more influential in the advanced markets in the sample than during the pre-crisis period. This implies the leading role of emerging markets during the recovery process after the GFC, as indicated in a study by the International Monetary Fund (2010a). A summary of the co-integration tests based on residuals can be seen in Table 5.3 below.

Table 5.3: Results of the bivariate co-integration based on residuals between the pairs of other markets

	Entire period	Pre-crisis period	Post-crisis period
HK	SG, TW, ML, VN	SG, TW, VN	TW, ML
JP		US, VN	ML, TL, VN
KR	TW, ML	TW, ML	TL, ML
SG	HK, TW, ML	HK, TW	TW, ML
TW	HK, KR, SG, ML, TL, VN	HK, KR, SG, ML, TL, VN	HK, SG, US, TL
US	VN	JP, SG, VN	SG, TW, ML
ML	KR, TW	KR, TW	KR, SG, TW, US, TL
TL	TW	TW	KR, TW, ML
VN	HK, SG, TW, US	HK, SG, TW, US, JP	

5.2.2 Bivariate co-integration with the presence of structural breaks

Given that the GFC may cause breaks in the data series, pair-wise co-integration between the Vietnamese and other equity markets, as well as between the pairs of other markets, is investigated to examine the bivariate co-integration relationships with the presence of structural breaks. The specifications of the tests are a model with a break in intercept, and a model with a break in intercept and trend.

The results reported in Table 5.4 below show that almost all empirical results reject the null hypothesis of co-integration between the Vietnamese and other equity-market levels. Only some evidence is found in favour of long-run co-integration, such as mono-directional co-integration from Hong Kong to Vietnam; bi-directional co-integration between Vietnam and Japan (model with intercept), and mono-directional co-integration from Vietnam to Korea (model with intercept and trend). Interestingly, the results are similar when compared to those for co-integration tests based on residuals with regard to the co-movement between Hong Kong, the US and Vietnam over the entire sample, and between Japan, Taiwan and Vietnam over the pre-crisis period. Additionally, there are several co-integration relationships found

during the post-crisis period, such as Vietnam–Singapore, Vietnam–US and Vietnam–Thailand (in the model with intercept and trend). These findings are not consistent with our previous findings with respect to long-run relationships based on residuals during the post-crisis period due to a lack of co-integration. Surprisingly, co-integration between Vietnam–Thailand is documented in both the empirical testing models during the pre-crisis period and in the model with intercept and trend during the post-crisis period. These findings provide support for a co-integrating relationship between the two markets when taking into account breaks in market-level data.

Table 5.4: Results of the bivariate co-integration allowing for structural breaks between the Vietnamese and selected market levels

	A model with breaks in intercept		A model with breaks in trend and intercept	
	ADF	Null hypothesis: No co-integration	ADF	Null hypothesis: No co-integration
Entire period				
VN–HK	−4.34	Rejected	−4.08	Not rejected
HK–VN	−4.17	Not rejected	−4.26	Not rejected
VN–JP	−4.65	Rejected	−4.29	Not rejected
JP–VN	−4.38	Rejected	−4.35	Not rejected
VN–KR	−3.58	Not rejected	−4.09	Not rejected
KR–VN	−3.35	Not rejected	−4.82	Rejected
VN–SG	−3.68	Not rejected	−4.1	Not rejected
SG–VN	−3.52	Not rejected	−3.75	Not rejected
VN–TW	−3.85	Not rejected	−3.93	Not rejected
TW–VN	−4.1	Not rejected	−4.39	Not rejected
VN–US	−4.37	Rejected	−4.1	Not rejected
US–VN	−3.93	Not rejected	−3.86	Not rejected
VN–ML	−3.29	Not rejected	−4.11	Not rejected
ML–VN	−2.85	Not rejected	−3.86	Not rejected
VN–TL	−2.67	Not rejected	−3.64	Not rejected
TL–VN	−2.85	Not rejected	−3.6	Not rejected
Pre-crisis period				
VN–HK	−3.49	Not rejected	−3.16	Not rejected
HK–VN	−3.78	Not rejected	−3.98	Not rejected
VN–JP	−4.45	Rejected	−3.51	Not rejected
JP–VN	−3.81	Not rejected	−3.95	Not rejected
VN–KR	−4.13	Not rejected	−3.35	Not rejected
KR–VN	−3.94	Not rejected	−4.01	Not rejected
VN–SG	−3.6	Not rejected	−3.36	Not rejected
SG–VN	−3.7	Not rejected	−3.74	Not rejected
VN–TW	−3.79	Not rejected	−2.9	Not rejected
TW–VN	−4.54	Rejected	−4.5	Not rejected

Table 5.4 (cont.)

VN-US	-3.81	Not rejected	-3.4	Not rejected
US-VN	-3.69	Not rejected	-3.89	Not rejected
VN-ML	-3.67	Not rejected	-3.25	Not rejected
ML-VN	-3.6	Not rejected	-3.89	Not rejected
VN-TL	-3.01	Not rejected	-2.67	Not rejected
TL-VN	-4.53	Rejected	-4.79	Rejected
Post-crisis period				
VN-HK	-4.06	Not rejected	-4.06	Not rejected
HK-VN	-4.01	Not rejected	-3.99	Not rejected
VN-JP	-3.3	Not rejected	-3.46	Not rejected
JP-VN	-3.41	Not rejected	-4.66	Not rejected
VN-KR	-3.49	Not rejected	-3.73	Not rejected
KR-VN	-3.68	Not rejected	-4.93	Rejected
VN-SG	-3.45	Not rejected	-3.79	Not rejected
SG-VN	-3.32	Not rejected	-3.77	Not rejected
VN-TW	-3.33	Not rejected	-3.68	Not rejected
TW-VN	-3.62	Not rejected	-4.6	Not rejected
VN-US	-3.12	Not rejected	-3.58	Not rejected
US-VN	-3.16	Not rejected	-5.79	Rejected
VN-ML	-3.69	Not rejected	-4.34	Not rejected
ML-VN	-3.11	Not rejected	-4	Not rejected
VN-TL	-3.82	Not rejected	-5.39	Rejected
TL-VN	-3.52	Not rejected	-5.29	Rejected

Notes: The AIC is chosen to select the number of lags. The critical values for the ADF test are -5.13, -4.61, -4.34 and -5.45, -4.99 and -4.72 in the model with breaks in intercept, and the model with a break in intercept and trend, respectively.

With regard to the results of the other markets under investigation, Table 5.5 below provides the empirical results of bivariate co-integration allowing for structural breaks. For instance, feedback co-movements between Hong Kong–Singapore, Singapore–Taiwan, Taiwan–Malaysia, Taiwan–Thailand, Korea–Malaysia and Malaysia–Thailand are exhibited in both models, and a mono-directional relationship from US–Hong Kong, US–Singapore and Hong Kong–US exists in the model with intercept and trend. As can be seen in the table, our findings reveal several different results with regard to the specifications of testing models and sub-periods. In addition, much evidence of co-integration linkages is found in the post-crisis period compared to the pre-crisis period, suggesting strong impacts of the GFC on the market linkages.

Table 5.5: Results of the bivariate co-integration allowing for structural breaks between pairs of equity-market indices

Entire period				Pre-crisis period				Post-crisis period			
Break in intercept		Break in intercept and trend		Break in intercept		Break in intercept and trend		Break in intercept		Break in intercept and trend	
Markets	t-statistic	Markets	t-statistic	Markets	t-statistic	Markets	t-statistic	Markets	t-statistic	Markets	t-statistic
HK-SG	-4.96**	HK-SG	-5.68*	HK-ML	-4.37***	HK-TW	-5.65*	HK-SG	-4.77**	HK-ML	-7.01*
JP-VN	-4.38***	HK-US	-5.24*	SG-TW	-4.88**	SG-TW	-5.11*	HK-ML	-5.4*	HK-TL	-6.08*
KR-ML	-4.87**	KR-ML	-4.82***	SG-US	-4.69**	TW-SG	-5.41**	HK-TL	-4.93**	JP-TL	-5.05**
KR-TL	-4.39***	KR-VN	-4.82***	TW-JP	-4.73**	TW-US	-5.45**	JP-KR	-4.51***	KR-JP	-5.03**
SG-HK	-4.75**	SG-HK	-5.53*	TW-KR	-4.47***	TW-TL	-4.87***	JP-SG	-4.61**	KR-SG	-4.92***
SG-TW	-5.00**	SG-TW	-5.08**	TW-SG	-5.41*	US-TW	-5.24*	JP-TW	-4.52***	KR-TW	-5.28**
TW-SG	-5.33*	SG-US	-5.14**	TW-US	-5.47*	TL-HK	-4.98***	JP-ML	-4.77**	KR-US	-4.81***
TW-ML	-5.14*	SG-ML	-5.28**	TW-TL	-4.56***	TL-JP	-5.1**	JP-TL	-5.2*	KR-ML	-4.97***
TW-TL	-4.37***	TW-SG	-5.52*	TW-VN	-4.54***	TK-KR	-4.83***	KR-ML	-4.81**	KR-TL	-5.72*
ML-TW	-4.86**	TW-ML	-5.17**	US-SG	-4.83**	TK-SG	-4.94***	KR-TL	-5.83*	KR-VN	-4.93***
ML-TL	-4.35***	TW-TL	-4.99**	US-TW	-5.14*	TK-US	-5.1**	SG-HK	-4.75**	SG-ML	-5.97*
VN-JP	-4.65**	US-HK	-5.09**	ML-HK	-4.52***	TK-ML	-4.76***	SG-ML	-5.38*	SG-TL	-4.93***
VN-US	-4.37***	US-SG	-5.21**	TL-HK	-4.39***			SG-TL	-4.63**	TW-KR	-4.84***
		ML-SG	-5.32**	TL-JP	-4.36***			TW-ML	-5.74*	TW-ML	-5.62*
		ML-TW	-4.91***	TL-KR	-4.99**			TW-TL	-5.42*	TW-TL	-5.47*
				TL-SG	-4.36***			US-ML	-5.26*	US-HK	-5.47*
				TL-TW	-4.6***			US-TL	-5.07**	US-KR	-5.67*
				TL-US	-4.37***			ML-HK	-4.64**	US-SG	-4.94***
				TL-ML	-4.6***			ML-TW	-5.1**	US-TW	-5.77*
				TL-VN	-4.53***			ML-US	-4.88**	US-ML	-5.96*
								ML-TL	-4.42***	US-TL	-6.09*
								TL-KR	-5.09**	ML-HK	-6.18*
								TL-TW	-4.92**	ML-SG	-5.26**
								TL-US	-4.75**	ML-TL	-5.07**
								TL-ML	-4.57*	VN-TL	-5.39**

Notes: The AIC is chosen to select the number of lags. The critical values for the ADF test are -5.13, -4.61, -4.34 and -5.45, -4.99 and -4.72 in the model with breaks in intercept, and the model with a break in intercept and trend, respectively.

It is notable that the results show evidence of co-movement among the markets during the entire sample, and pre- and post-crisis periods, which is not in line with findings by Huang, Yang and Hu (2000), who do not find evidence of bivariate co-integrations among Hong Kong, Taiwan and the US when taking the AFC into account. Similarly, our findings are not consistent with the findings by Fernández-Serrano and Sosvilla-Rivero (2001) or Leong and Felmingham (2003), who take into account breaks in time series data of Asian equity markets and suggest evidence in favour of long-run relationships such as Taiwan–Japan over the period 1987–1992 and Korea–Singapore, Singapore–Japan and Korea–Japan over the period 1990–2000. Our reasons for the different results of co-integration relationships among these studies are different periods of study as well as different crises examined. In addition, much evidence in favour of the long-run relationships between the US and other markets in the sample is found in our study during the post-crisis period, suggesting significant changes in the relationships between the US equity market and the other markets (for example, Hong Kong, Korea, Singapore, Taiwan, Malaysia, Thailand and Vietnam in the model with breaks in intercept and trend) during the post-GFC. In other words, our findings imply significant impacts of the GFC on the linkages between the US and other markets in the sample.

The results also show evidence of long-run relationships between both the Thai and Malaysian markets and advanced markets during the post-crisis period, which is consistent with our previous findings on the long-run co-integration tests based on residuals. A summary of the co-integration tests between and among pairs of equity markets in the sample are shown in Table 5.6 below.

Table 5.6: Results of the bivariate co-integration with the presence of structural breaks between pairs of selected markets

	Breaks in intercept	Breaks in trend and intercept
Entire period		
HK	SG	SG, US
JP	VN	
KR	ML, TL	ML, VN
SG	HK, TW	HK, TW, US, ML
TW	SG, ML, TL	SG, ML, TL
US		HK
ML	TW, TL	SG, TW
TL		
VN	HK, JP, US	KR
Pre-crisis period		
HK	ML	TW
JP		
KR		
SG	TW, US	TW
TW	JP, KR, SG, US, TL, VN	US, TL
US	SG, TW	TW
ML	HK	
TL	HK, JP, KR, SG, TW, US, ML, VN	JP, KR, SG, US, ML, VN
VN	JP	
Post-crisis period		
HK	SG, ML, TL	ML, TL
JP	KR, SG, TW, ML, TL	TL
KR	ML, TL	JP, SG, TW, US, ML, TL, VN
SG	HK, ML, TL	ML, TL
TW	ML, TL	KR, ML, TL
US	ML, TL	HK, KR, SG, TW, ML, TL, VN
ML	HK, TW, US, TL	HK, SG, TL
TL	KR, TW, US, ML	
VN		TL

5.2.3 Co-integration based on the VAR model

Co-integration relationships among the equity-market levels are further investigated by using the multivariate co-integration based on the VAR model suggested by Johansen (1988) and Johansen and Juselius (1990). In the test, the optimum lag length is identified by the lowest value between the SIC and AIC. The specification on linear deterministic trend with intercept and no trend is examined.

The results in Table 5.7 below show evidence in favour of co-integration between the Vietnamese equity market and other equity-market levels during the entire sample and sub-periods. This finding is in line with our previous findings, such as the long-run relationship between Vietnam and each of Hong Kong, Japan and the US during the entire sample period, and between Vietnam–Japan and Vietnam–Taiwan during the pre-crisis period. However, the empirical results during the post-crisis period are not consistent with our findings in the previous tests because many co-integrating vectors are presented - for example, two co-integrating vectors between Vietnam–Hong Kong and between Vietnam–Singapore, and one co-integrating vector between Vietnam–Korea, Vietnam–Singapore and Vietnam–Taiwan. Interestingly, we find more evidence of co-integrating vectors between the Vietnamese and advanced markets rather than between the Vietnamese and emerging markets during the entire sample and sub-periods. This implies that the Vietnamese equity market tends to co-move with the advanced markets in the long run.

Table 5.7: Results of the bivariate co-integration based on the VAR model between the Vietnamese and other market levels

		Entire period			Pre-crisis period			Post-crisis period		
		Trace	Max. Eigen	Lag	Trace	Max. Eigen	Lag	Trace	Max. Eigen	Lag
VN–HK	None	18.8*	18.1*		16.1*	16.0*		19.1*	14.5*	
	At most 1	0.7	0.7	2	0.1	0.1	2	4.6*	4.6*	2
VN–JP	None	26.4*	23.9*		39.7*	38.4*		34.1*	23.7*	
	At most 1	2.5	2.5	2	1.3	1.3	2	10.3*	10.3*	1
VN–KR	None	7.2	6.3		6.5	5.7		18.9*	18.3*	
	At most 1	0.9	0.9	2	0.8	0.8	3	0.6	0.6	2
VN–SG	None	16.8*	16.3*		15.0	14.7*		19.1*	16.5*	
	At most 1	0.5	0.5	2	0.2	0.2	2	2.6	2.6	2
VN–TW	None	21.7*	20.7*		18.4*	17.6*		22.3*	19.7*	
	At most 1	1.0	1.0	2	0.8	0.8	2	2.6	2.6	2
VN–US	None	20.3*	18.8*		27.8*	27.2*		15.6*	13.6	
	At most 1	1.6	1.6	2	0.7	0.7	2	2.0	2.0	2
VN–ML	None	8.3	7.3		9.2	7.6		15.4	13.6	
	At most 1	1.0	1.0	2	1.6	1.6	2	1.8	1.8	2
VN–TL	None	5.8	4.8	2	5.3	3.5	3	14.1	13.6	
	At most 1	1.0	1.0		1.7	1.7		0.4	0.4	2

Note: * denotes rejections of the hypothesis at the 5 per cent level of significance.

Table 5.8: Results of bivariate co-integration based on the VAR model between pairs of selected markets

	Entire period			Pre-crisis period			Post-crisis period									
		Trace	Max. Eigen	Lag		Trace	Max. Eigen	Lag		Trace	Max. Eigen	Lag				
HK–TW	None	17.1*	15.8*	2	HK–VN	None	16.1*	16.0*	2	HK–JP	None	17.5*	14.3*	1		
	At most 1	1.3	1.3			At most 1	0.1	0.1			At most 1	3.2	3.2			
HK–VN	None	18.8*	18.1*	2	JP–VN	None	39.7*	38.4*	2	HK–SG	None	18.7*	12.0	1		
	At most 1	0.7	0.7			At most 1	1.3	1.3			At most 1	6.7*	6.7*			
JP–VN	None	26.4*	23.9*	2	KR–TW	None	20.3*	19.3*	2	HK–TW	None	24.6*	13.6	1		
	At most 1	2.5	2.5			At most 1	1.0	1.0			At most 1	11.0*	11.0*			
KR–TW	None	16.1*	15.2*	2	SG–TW	None	22.7*	22.3*	2	HK–US	None	15.1*	9.6	1		
	At most 1	0.8	0.8			At most 1	0.4	0.4			At most 1	5.5	5.5*			
KR–ML	None	15.7*	15.5*	2	TW–ML	None	23.3*	22.8*	2	HK–ML	None	17.0*	11.7	1		
	At most 1	0.2	0.2			At most 1	0.5	0.5			At most 1	5.3*	5.3*			
SG–TW	None	28.2*	27.5*	2	TW–TL	None	18.3*	16.2*	1	HK–VN	None	19.1*	14.5*	2		
	At most 1	0.7	0.7			At most 1	2.1	2.1			At most 1	4.6*	4.6*			
SG–VN	None	16.8*	16.3*	2	TW–VN	None	18.4*	17.6*	2	JP–KR	None	16.7*	15.8*	1		
	At most 1	0.5	0.5			At most 1	0.8	0.8			At most 1	0.9	0.9			
TW–US	None	11.4	7.2	3	US–VN	None	27.8*	27.2*	2	JP–SG	None	17.5*	14.6*	2		
	At most 1	4.2*	4.2*			At most 1	0.7	0.7			At most 1	2.9	2.9			
TW–ML	None	20.3*	20.2*	2						JP–TW	None	22.2*	19.0*	1		
	At most 1	0.0	0.0								At most 1	3.2	3.2			
TW–TL	None	20.3*	19.8*	1						JP–VN	None	34.1*	23.7*	1		
	At most 1	0.6	0.6								At most 1	10.3*	10.3*			
TW–VN	None	21.7*	20.7*	2						KR–SG	None	19.0*	12.9	1		
	At most 1	1.0	1.0								At most 1	6.1*	6.1*			
US–VN	None	26.4*	23.9*	2						KR–TW	None	21.8*	17.8*	1		
	At most 1	2.5	2.5								At most 1	4.1*	4.1*			
										KR–US	None	19.3*	11.1	2		
											At most 1	8.2*	8.2*			
										KR–ML	None	38.5*	31.3*	1		
											At most 1	7.2*	7.2*			

Table 5.8 (cont.)

KR–TL	None	27.8*	24.2*	1
	At most 1	3.6	3.6	
KR–VN	None	18.9*	18.3*	2
	At most 1	0.6	0.6	
SG–TW	None	31.2*	17.9*	2
	At most 1	13.3*	13.3*	
SG–US	None	18.8*	10.6	2
	At most 1	8.1*	8.1*	
SG–ML	None	22.9*	15.1*	1
	At most 1	7.8*	7.8*	
SG–VN	None	19.1*	16.5*	2
	At most 1	2.6	2.6	
TW–US	None	44.3*	31.4*	1
	At most 1	12.8*	12.8*	
TW–ML	None	35.7*	27.3*	1
	At most 1	8.4	8.4	
TW–TL	None	22.1*	19.4*	1
	At most 1	2.8*	2.8*	
TW–VN	None	22.3*	19.7*	2
	At most 1	2.6	2.6	
US–ML	None	14.0	9.8	2
	At most 1	4.2*	4.2*	
US–VN	None	15.6*	13.6	2
	At most 1	2.0	2.0	
ML–TL	None	16.7*	13.1	1

Note: * denotes rejections of the hypothesis at the 5 per cent level of significance.

In terms of the co-integration relationship between pairs of the other markets in the sample, the results in Table 5.8 above provide support for the existence of a number of co-integrating vectors. The leading role of Taiwan is confirmed as it is widely co-integrated with many of the other markets over the entire sample and sub-periods. More importantly, the empirical findings support the argument of emerging markets taking a leading recovery during the post-crisis period.

With respect to the long-run movement among the three groups of market levels, we firstly select an appropriate lag length for each group. Based on the lowest values of the AIC and SIC, we identify at least one lag length for the entire sample and sub-periods. Specifically, in the advanced and emerging market groups, we find two lag lengths for the entire and pre-crisis periods, and one lag for the post-crisis period, while in the entire market group, two lag lengths for the entire sample and one lag length for the pre- and post-crisis periods are found. Next, we check for the serial correlation of residual series by employing the autocorrelation Lagrange multiplier test, and find we cannot reject the null hypothesis of no serial correlation for all groups. As such, we conduct the multivariate co-integration tests for the three groups: advanced, emerging and entire markets. The empirical findings are shown in Table 5.9 below including the lag-length selection and a number of co-integration vectors over the entire sample and sub-periods.

The empirical findings show that one co-integrating vector exists among the advanced equity markets for the entire sample period and sub-periods. In addition, two co-integration vectors are identified among all markets during the pre-crisis period, but only one vector is reported post-crisis. These findings are consistent with Kenourgios and padhi (2012), who also find only one co-integrating vector in the relationship among the emerging and advanced markets over the period of three crises including the Russian crisis, the Asian crisis and the subprime crisis.

More importantly, the fact that no co-integrating vector is found among three emerging markets during the entire sample and sub-periods supports our previous argument of the lack of long-run co-movement among the emerging markets under examination. The absence of co-integration among these markets can in part be explained by different degrees of integration and market development among these countries.

With regard to the group of all markets, we find that two co-integrating vectors exist among the markets during the entire and pre-crisis periods, but only one co-integrating vector during the post-crisis period. Our findings are not consistent with the results of Yang and Lim (2004), who find only one co-integrating vector among Hong Kong, Japan, Korea, Singapore, Malaysia, Thailand and Taiwan before the AFC, but the absence of co-integrating vectors among these markets after the crisis. These different results could be explained by different periods of study as well as samples examined between the studies.

Table 5.9: Results of the multivariate co-integration based on the VAR model

Market	Null hypothesis	Entire period			Pre-crisis period			Post-crisis period		
		Trace	Max. Eigen	Lag	Trace	Max. Eigen	Lag	Trace	Max. Eigen	Lag
Advanced markets	None *	114.2*	45.2*		112.7*	45.6*		108.6*	44.6*	
	At most 1	69.0	38.3*		67.1	36.6*		64.0	21.9	
	At most 2	30.6	14.7	2	30.5	15.2		42.1	18.6	1
	At most 3	15.9	11.3		15.3	9.7		23.6	14.5	
	At most 4	4.6	4.6		5.6	5.0		9.1	8.3	
	At most 5	0.0	0.0		0.7	0.7	2	0.8	0.8	
Emerging markets	None	23.0	18.6		24.6	19.2		33.9*	20.7	
	At most 1	4.5	4.1	2	5.4	3.9		13.2	12.5	1
	At most 2	0.3	0.3		1.5	1.5	2	0.7	0.7	
All markets	None	244.8*	74.1*		268.0*	85.6*		237.9*	67.8*	
	At most 1	170.7*	60.2*		182.4*	61.8*		170.0*	44.9	
	At most 2	110.5	37.9		120.6	49.9*		125.1	39.0	
	At most 3	72.5	27.8		70.8	25.7		86.2	24.8	
	At most 4	44.7	20.0	2	45.1	16.5		61.3	19.7	1
	At most 5	24.7	12.3		28.6	12.7		41.6	17.2	
	At most 6	12.5	6.3		15.9	8.6		24.4	13.0	
	At most 7	6.2	5.8		7.3	5.4		11.4	11.3	
	At most 8	0.4	0.4		1.9	1.9	1	0.1	0.1	

Notes: The specification of the model is a linear deterministic trend in intercept. * denotes rejections of the hypothesis at the 5 per cent level of significance.

In summary, although known as a relatively small and young market, the Vietnamese equity market exhibits strong evidence of long-run relationships with both Japan and Taiwan over the pre-crisis period as supported by all three co-integration testing models. During the post-crisis period, evidence found in the relationship between the Vietnamese and other equity markets is not strongly supported across three bivariate co-integration tests. Thus we cannot draw any conclusions with respect to the long-run relationships between the Vietnamese and other markets during this period. However, given that there is a lack of empirical study on the long-run relationship between the Vietnamese and the global markets, this result extends the

current literature on this relationship regarding the Asian emerging markets (Ghosh, Saidi and Johnson 1999; Click and Plummer 2005; Shabri Abd. Majid, Kameel Mydin Meera and Azmi Omar 2008; Huyghebaert and Wang 2010).

The results show different empirical findings during the pre-crisis period compared to those during the post-crisis period. The significant changes can be explained by the differences in economic policies and the development of financial markets across the countries after the crisis (International Monetary Fund 2009), supporting the different effects of the GFC on the long-run relationship between the Vietnamese equity market and its major partners as well as pairs of the other markets. Interestingly, the results show a co-movement of other markets toward the emerging markets after the GFC, confirming the findings of the International Monetary Fund (2010a) on the leading role of emerging markets during the global recovery. More importantly, findings with respect to the long-run movement between the markets are not consistent among the three employed co-integration testing models. This is in line with the studies by Gupta and Guidi (2012) and Fernández-Serrano and Sosvilla-Rivero (2001), who cannot find clear evidence on the co-integration relationships among different types of empirical tests. They argue that the conflicting results are due to different research models and suggest employing other techniques to identify the nature of relationship among the markets.

5.3 Causal relationships among the equity markets

The long-run relationships discussed in the last section reveal much of the co-movement between and among the Vietnamese equity market and other equity markets; however, there may be possible short-term relationships among these markets as well. This section employs a technique to discover the causal relationships between pairs of the equity-market returns and the groups of market returns. Specifically, we employ pair-wise Granger causality tests (Granger 1969) and multivariate Granger causality tests based on the VAR model (Granger 1988). Further analyses of a short-run relationship are undertaken using VAR analysis techniques. These tests are performed for the entire sample, and pre- and post-crisis periods.

5.3.1 Pair-wise Granger causality

The pair-wise Granger causality test is employed to explore how a current return to the Vietnamese equity market can be explained by past returns to the Vietnamese equity market and lagged returns to other markets across the entire sample and sub-periods. Two series of

market returns are said to be Granger-caused if they are statistically significant based on the F-test.

The results of pair-wise Granger causality between Vietnamese equity-market returns and other market returns in Table 5.10 below illustrate that the Vietnamese equity-market returns exhibit a feedback directional relationship with the Japanese, Korean and Singaporean equity markets. One-way directional relationships are found from the rest of other market returns to the Vietnamese market over the entire sample period. Interestingly, the results show that Vietnamese market returns exhibit Granger causality to the US equity-market returns during the post-crisis period, while no evidence of Granger causality is displayed during the pre-crisis period.

Table 5.10: Results of the pair-wise Granger causality between the Vietnamese and other market returns

Null hypothesis:	Entire period	Pre-crisis period	Post-crisis period
VN does not Granger-cause HK	2.56	4.26*	4.61*
HK does not Granger-cause VN	17.9*	3.40*	2.75
VN does not Granger-cause JP	6.02*	11.60*	2.61
JP does not Granger-cause VN	4.47*	1.07	3.22*
VN does not Granger-cause KR	4.49*	4.00*	3.76*
KR does not Granger-cause VN	9.53*	3.28*	4.23*
VN does not Granger-cause SG	3.44*	4.93*	4.16*
SG does not Granger-cause VN	19.18*	4.91*	5.58*
VN does not Granger-cause TW	1.43	2.02	1.09
TW does not Granger-cause VN	11.16*	6.28*	4.65*
VN does not Granger-cause US	0.05	1.51	2.78
US does not Granger-cause VN	0.92	0.72	8.58*
VN does not Granger-cause ML	0.10	0.86	0.71
ML does not Granger-cause VN	13.31*	4.40*	5.75*
VN does not Granger-cause TL	0.10	3.59*	3.79*
TL does not Granger-cause VN	10.01*	1.01	4.36*

Notes: The lag number is 2.* denotes a rejection of the null hypothesis of no Granger cause based on the F-statistic at a 5 per cent level of significance.

Table 5.11 below shows evidence of the causal relationships between pairs of the other markets in the study. An interesting feature is that during the entire and pre-crisis periods, the US equity-market returns reveal both leading and lagging roles to the other markets; however, during the post-crisis period, the market is mostly explain by lagged values of the other market returns. These findings are not consistent with previous studies by Huang, Yang and Hu (2000) and Huyghebaert and Wang (2010), who document the leading roles of the US to several East Asian equity markets after the AFC. However, they are consistent with Cheung, Fung and Tsai (2010), who document changes in the role of the US over the GFC

(from 7/2007 to 4/2009). In addition, our findings are not in line with the empirical results of Yang and Lim (2004), who report no evidence of causal relationships from Japan to Hong Kong, Korea, Malaysia, Thailand, Singapore and Taiwan during the AFC (Yang & Lim 2004). Additionally, contradictory results with respect to a causal relationship between the Taiwanese equity market and other markets are discovered when compared to the findings of Yang and Lim (2004).

Table 5.11: Results of the pair-wise Granger causality between the pairs of selected market returns

Entire period	JP	KR	SG	TW	US	ML	TL	VN
HK	↔	↔	↔	→	↔	↔	→	→
JP		↔	↔	→	↔	↔	↔	↔
KR			↔	→	↔	→	↔	↔
SG				↔	↔	→	↔	↔
TW					↔	↔	↔	↔
US						↔	↔	↔
ML							↔	→
TL								→
Pre-crisis	JP	KR	SG	TW	US	ML	TL	VN
HK	→	↔	↔	→	↔			↔
JP		↔	↔	→	↔			↔
KR			↔	→	↔		↔	↔
SG				↔	↔	↔		↔
TW					→	↔	↔	→
US						↔	↔	↔
ML							↔	→
TL								→
Post - crisis	JP	KR	SG	TW	US	ML	TL	VN
HK	→		↔	→	↔			↔
JP			↔		↔	↔	↔	↔
KR			↔		↔	↔	↔	↔
SG				→	↔	↔	↔	↔
TW					→		↔	↔
US						↔	↔	↔
ML							↔	↔
TL								↔

Notes: The lag specification in the equation is 2. \leftarrow , \rightarrow , \leftrightarrow denotes the direction of the Granger cause based on the F-statistic at a 5 per cent level of significance.

Interestingly, we observe that the Singaporean market leads all the markets in the sample during the post-crisis period. This is not in line with Yang and Lim (2004), who find a less influential role for Singapore over East Asian markets during the post-AFC period.

In brief, the significant changes in the causal relationships among the markets found in the bivariate causality tests during the pre- and post-crisis periods confirm the effects of the GFC on global-equity market linkages.

5.3.2 Multivariate Granger causality

As the evidence pertaining to bivariate co-integration between pairs of the equity-market levels is conflicted, this thesis also examines the multivariate Granger causality tests among groups of markets, advanced and emerging. Using the results in the multivariate co-integration relationship tests, the VEC model in the market levels is employed for the advanced and the entire market groups, while the VAR model in market returns is performed for the emerging market group. In these tests, the lag length is selected as the lower values of the AIC and SIC as discussed in the studies by Daly (2003) and Fayyad and Daly (2011).

For the multivariate Granger causality among the emerging market group, Table 5.12 below shows evidence supporting the influence of one market over other markets, such as mono-directional causality from Malaysia–Vietnam and a feedback directional relationship between Thailand–Malaysia during the pre-crisis period. However, no causal linkage among pairs of markets is discovered during the post-crisis period, except for a constant, since an appropriate lag length for the VAR model of market returns is zero. Surprisingly, the results display no predictability of the lagged values of the Thai market returns on its future values during the entire sample and pre-crisis periods. This finding may raise the issue of a random movement of the Thailand equity market.

Table 5.12: Results of the multivariate Granger causality among the emerging market returns

	Short-run lagged returns				
	VN(−1)	ML(−1)	TL(−1)	C	Lag
Entire period					
Dep. VAR	VN(−1)	ML(−1)	TL(−1)	C	Lag
VN	0.231*	0.132*	0.067*	0.013	
ML	−0.006	0.132*	0.040*	0.044	1
TL	−0.001	0.089*	−0.010	0.0589**	
Pre-crisis period					
Dep. VAR	VN(−1)	ML(−1)	TL(−1)	C	Lag
VN	0.231*	0.073**	0.015	0.059**	
ML	−0.011	0.140*	0.037*	0.013	1
TL	−0.035**	0.061**	−0.011	0.044	
Post-crisis period					
Dep. VAR	VN(−1)	ML(−1)	TL(−1)	C	Lag
VN				0.141**	
ML				0.111*	0
TL				0.182*	

Notes: *, ** denotes a rejection of the null hypothesis of no Granger cause based on the t-statistic at 5 per cent and 10 per cent levels of significance respectively.

Regarding the advanced market group, Table 5.13 below documents much evidence of causal linkages among the market returns during the entire and pre-crisis periods. The results also suggest a dominant role for Singaporean equity-market returns because of Singapore's influence on the other equity-market returns under observation throughout the pre-crisis period. Interestingly, although the US exhibits Granger causality to Hong Kong and Singapore during the entire sample period, these relationships are dismissed during the pre-crisis period.

Interestingly, different results are found in the multivariate Granger causality among the advanced markets during the pre- and post-crisis periods. Specifically, since there is one co-integrating vector among the market levels over the sub-periods, the VEC models are employed to investigate their causal relationship among market returns. However, it is notable that based on the lower values of the AIC and SIC, we select two lag lengths for the pre-crisis period and one lag length for the post-crisis period for the market levels. Thus, the findings with respect to causal relationships among lagged values of the market returns are reported only during the pre-crisis period, while impacts of the co-integrating vector and constant term are found during the post-crisis period. That no impacts of the lagged values of endogenous variables on the causal relationship during the post-crisis period exist is not surprising; however, the result should be considered with caution. The most appropriate interpretation is that this may be due to the relatively short time frame examined for the post-crisis period (1/3/2009–31/12/2010).

Table 5.13: Results of the multivariate Granger causality among the advanced market returns

Dep. VEC	Short-run lagged market returns						ECT term	Constant	No. of co-integ.	Lag of market levels
	US	HK	JP	KR	SG	TW	ETC	C		
Entire period										
US	−0.2458*	0.1181*	0.0452*	0.0368	0.1820*	−0.0108	−0.0007	−0.00011	1	2
HK	0.0611*	−0.1789*	−0.0808*	0.0683*	0.2978*	−0.0843*	0.0010	0.00005		
JP	−0.0017	−0.0066	−0.1371*	0.0279	0.3012*	−0.0477*	0.0007	−0.00025		
KR	0.0354	−0.0759*	−0.0690*	−0.0185	0.2424*	−0.0093	0.0043*	0.00035		
SG	0.0730*	−0.0775*	−0.0621*	0.0194	0.1103*	−0.0484*	−0.0011	0.00013		
TW	−0.0011	0.0407	−0.0218	0.0295	0.2010*	−0.0642*	0.0044*	−0.00001		
Pre-crisis period										
US	−0.1616*	0.0113	0.0621*	0.0306	0.1361*	0.0046	−0.0158*	−0.0001	1	2
HK	0.0458	−0.1239*	−0.0659*	0.0517*	0.2060*	−0.0699*	0.0129	0.0001		
JP	−0.0135	−0.0296	−0.1117*	0.0268	0.2212*	−0.0163	0.0187*	−0.0001		
KR	−0.0112	−0.0450	−0.0373	−0.0152	0.1749*	−0.0073	0.0262*	0.0003		
SG	0.0024	−0.0698*	−0.0339	0.0165	0.0930*	−0.0466*	0.0234*	0.0001		
TW	−0.0191	0.0410	0.0141	0.0532	0.1441*	−0.0649*	0.0288*	−0.0001		
Post-crisis period										
US							−0.0926*	0.0011	1	1
HK							−0.0366	0.0012		
JP							−0.0003	0.0006		
KR							0.0168	0.0014*		
SG							−0.0295	0.0014*		
TW							0.0095	0.0014*		

Notes: *, ** denotes a rejection of the null hypothesis of no Granger cause based on the t-statistic at a 5 per cent level of significance.

Table 5.14: Results of the multivariate Granger causality among the entire market returns

Entire period	Short-run lagged market returns									Error correction term			Lag of market levels
	US(-1)	HK(-1)	JP(-1)	KR(-1)	ML(-1)	SG(-1)	TL(-1)	TW(-1)	VN(-1)	ECT 1	ECT 2	C	
Dep. VAR													
US	-0.230*	0.108*	0.046*	0.036	-0.069*	0.164*	0.064*	-0.01	-0.013	-0.019*	-0.002*	-0.0001	
HK	0.068*	-0.174*	-0.075*	0.069*	-0.049	0.305*	-0.02	-0.081*	-0.005	-0.006	-0.005	0.0001	
JP	0.014	-0.007	-0.128*	0.027	-0.093*	0.307*	0.017	-0.044	-0.035	-0.005	-0.004	-0.0002	
KR	0.045	-0.082*	-0.062*	-0.021	-0.072	0.236*	0.051	-0.013	-0.014	-0.001	-0.009	0.0004	
ML	-0.019	0.008	-0.032*	0.007	0.112*	0.077*	0.023	-0.008	-0.001	-0.002	-0.003	0.0002	2
SG	0.076*	-0.076*	-0.058*	0.017	-0.065	0.119*	0.021	-0.045*	-0.007	0.006	-0.000*	0.0001	
TL	0.074*	-0.046	-0.050*	0.080*	0.07	0.022	-0.013	-0.027	-0.007	-0.003	-0.001*	0.0004	
TW	0.001	0.035	-0.016	0.027	-0.001	0.189*	0.034	-0.071*	-0.022	0.005	-0.008*	0	
VN	-0.099*	0.065*	-0.023	0.012	0.108*	0.054	0.02	0.036	0.224*	-0.038*	0.006	0.0004	
Pre-crisis period													
Dep. VAR													
US	US(-1)	HK(-1)	JP(-1)	KR(-1)	ML(-1)	SG(-1)	TL(-1)	TW(-1)	VN(-1)	ECT 1	ECT 1	C	
										-0.010*	-0.002	0	1
HK										0.004	-0.008*	0.0001	
JP										0.007	-0.008*	-0.0001	
KR										0.010	-0.013*	0.0003	
ML										0.003	-0.006*	0.0002	
SG										0.010*	-0.003	0.0001	
TL										0.008	-0.003	0.0004	
TW										0.012*	-0.013*	-0.0001	
VN										-0.043*	0.007*	0.0008*	

Table 5.14 (cont.)

Post-crisis period

Dep. VAR	US(-1)	HK(-1)	JP(-1)	KR(-1)	ML(-1)	SG(-1)	TL(-1)	TW(-1)	VN(-1)	ECT 1	C	1
US										-0.065*	0.0011	
HK										-0.036*	0.0012	
JP										-0.007	0.0006	
KR										0.017	0.0014*	
Dep. VAR	US(-1)	HK(-1)	JP(-1)	KR(-1)	ML(-1)	SG(-1)	TL(-1)	TW(-1)	VN(-1)	ECT 1	C	
ML										-0.030*	0.0011*	
SG										-0.030*	0.0014*	
TL										-0.035*	0.0018*	
TW										0.004	0.0014*	
VN										-0.055*	0.0014	

Notes: *, ** denote a rejection of the null hypothesis of no Granger cause based on the t-statistic at 5 per cent and 10 per cent levels of significance, respectively.

In terms of the results pertaining to causal relationships among all the markets under consideration, Table 5.14 above documents the leading roles of Singapore and Japan in other markets since they significantly influence almost all other markets. This finding is somewhat consistent with Huyghebaert and Wang (2010), who find evidence in favour of an important role of the markets in East Asia. In addition, the US exhibits both lead and lag relationships with the other markets - for example, feedback relationships with Hong Kong, Singapore and Thailand, and mono-directional relationships with Japan and Malaysia. Our findings are somewhat inconsistent with the findings of Janakiramanan and Lamba (1998), who find influences of the US on the Pacific Basin region, including Hong Kong, Japan, Singapore, Malaysia and Thailand, but not vice versa, during the period 1988–1996. Notably, our results show evidence of causal linkages between the Vietnamese equity market and regional and global markets because its market returns are led by US, Hong Kong and Malaysian equity-market returns and the co-integrating vector during the entire sample period; however, its lagged market returns do not affect any of the equity markets under consideration. This implies that the Vietnamese equity-market returns lag in terms of their relationships with the other markets in the sample.

By partitioning the sample of study into the pre- and post-crisis periods, we investigate the effects of the GFC on the causal relationships among the markets. The findings indicate that an appropriate lag length for the VAR model is one for market levels. However, because we find that one co-integrating vector exists among the market levels, the VEC models are used to explore the causal relationships among the entire market during the sub-periods. The empirical findings indicate the effects of only the co-integrating vector and a constant term on the causal relationships among the equity-market returns rather than lagged values of endogenous variables in the model. In other words, the results imply less significance for lagged values of market returns on the causal relationships. These findings imply that the causal relationships among the entire markets are adjusted by the ECTs discovered in their long-run relationships rather than their lagged values. However, these results need to be viewed with caution. We interpret these findings as being the result of our parsimonious criterion in the lag-length selection for the VAR model (the lowest values of the AIC and SIC) and a short time frame used during the post-crisis period (1/3/2009–31/12/2010).

5.3.3 VAR analysis

This section discusses further analyses of the short-term relationships among the three groups of markets (emerging, advanced and all markets). We employ VAR models for the emerging market returns group and VEC models for the advanced and entire market levels groups. Two types of tests, namely variance decomposition and accumulated generalised impulse response function, are examined over the entire sample, and pre- and post-crisis periods.

5.3.3.1 Variance decomposition

By investigating the effects of a shock on one market's variance on other markets, variance decomposition is used in the group of nine equity markets. The empirical findings for variance decomposition of all markets are reported in Table 5.15 below. Findings regarding the emerging and advanced market groups are shown in Appendix 5.1. The table provides the variance decomposition of the five-day ahead.

For the Vietnamese equity market, the results provide general support for an endogenous characteristic, indicating that the variance of the market can be explained by its own lagged values, as it can explain for over 89 per cent of its variances at period four over the entire sample and sub-periods. Notably, US equity-market levels are the most exogenous, with 7 per cent variance explained for variance of the Vietnamese markets levels. It is likely to support a minor role in the forecast error variance of the other markets to the Vietnamese market. This finding is in line with our previous results with regard to the VAR estimation.

Regarding other markets under consideration, the results present significant influences of innovations of the US market on the advanced markets, and those of the Hong Kong market on the emerging markets in the VAR system during the entire sample and sub-periods. In addition, the Singaporean equity market is considered the most exogenous, with over 50 per cent of its variance explained by other markets, mainly the Hong Kong market. Interestingly, both the Hong Kong and Japanese equity markets may be considered intermediaries for the transmission of the GFC on the examined markets because their forecast error variances can be strongly explained by each innovation of the US. Note that the variances of all markets have more exogenous effects over the post-crisis period than over the pre-crisis period, supporting for significant effects of the GFC on the relationships among the markets.

Table 5.15: Variance decomposition of the selected equity markets

Entire period										
	Period	US	HK	JP	KR	SG	TW	ML	TL	VN
US	1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	92.38	4.47	0.28	0.28	1.92	0.04	0.31	0.28	0.04
HK	1	18.04	81.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	19.75	77.33	0.06	0.28	2.03	0.36	0.18	0.00	0.00
JP	1	23.75	17.09	59.16	0.00	0.00	0.00	0.00	0.00	0.00
	5	25.28	20.98	50.81	0.14	2.17	0.16	0.31	0.02	0.12
KR	1	12.03	24.39	7.17	56.41	0.00	0.00	0.00	0.00	0.00
	5	12.99	22.97	5.38	56.78	1.49	0.04	0.19	0.15	0.01
SG	1	14.49	35.48	1.64	2.38	46.02	0.00	0.00	0.00	0.00
	5	16.30	29.39	0.93	2.77	50.36	0.13	0.08	0.03	0.01
TW	1	9.61	14.08	2.29	7.69	1.25	65.07	0.00	0.00	0.00
	5	12.30	19.00	1.81	8.76	4.70	53.30	0.02	0.07	0.03
ML	1	8.03	10.99	0.92	0.74	5.81	0.29	73.20	0.00	0.00
	5	7.33	13.28	0.42	1.10	10.26	0.14	67.37	0.10	0.00
TL	1	5.67	15.08	0.96	1.13	3.25	0.31	1.82	71.78	0.00
	5	7.41	14.37	0.72	2.51	4.01	0.16	2.45	68.36	0.01
VN	1	2.10	0.08	1.13	0.02	0.01	0.00	0.02	0.07	96.58
	5	1.32	2.23	1.48	0.02	0.50	0.13	0.05	0.16	94.12
Pre-crisis period										
	Period	US	HK	JP	KR	SG	TW	ML	TL	VN
US	1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	99.83	0.01	0.00	0.00	0.10	0.00	0.05	0.00	0.00
HK	1	17.98	82.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	18.11	81.68	0.03	0.00	0.11	0.01	0.04	0.00	0.00
JP	1	15.32	17.14	67.55	0.00	0.00	0.00	0.00	0.00	0.00
	5	15.97	16.80	67.12	0.00	0.07	0.01	0.03	0.00	0.00
KR	1	12.44	21.43	6.74	59.39	0.00	0.00	0.00	0.00	0.00
	5	12.68	20.49	5.80	60.81	0.14	0.02	0.05	0.00	0.00
SG	1	13.83	30.30	2.36	2.36	51.14	0.00	0.00	0.00	0.00
	5	14.72	29.24	2.06	2.47	51.51	0.00	0.00	0.00	0.00
TW	1	9.77	9.83	2.14	6.92	1.03	70.31	0.00	0.00	0.00
	5	10.25	9.05	1.59	7.32	1.74	69.99	0.04	0.00	0.00
ML	1	8.37	8.15	0.85	0.28	4.37	0.33	77.65	0.00	0.00
	5	8.52	7.85	0.60	0.32	5.96	0.24	76.50	0.00	0.00
TL	1	4.13	8.25	0.79	1.90	2.74	0.55	2.31	79.34	0.00
	5	4.41	7.81	0.66	1.96	2.73	0.52	2.37	79.55	0.00
VN	1	0.06	0.00	0.62	0.00	0.03	0.01	0.00	0.00	99.28
	5	0.06	0.21	1.12	0.01	0.05	0.02	0.09	0.02	98.42
Post-crisis period										
	Period	US	HK	JP	KR	SG	TW	ML	TL	VN
US	1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	96.87	0.35	0.34	1.45	0.06	0.68	0.03	0.23	0.00
HK	1	15.13	84.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	12.57	86.90	0.06	0.27	0.01	0.13	0.00	0.04	0.00
JP	1	33.09	16.04	50.87	0.00	0.00	0.00	0.00	0.00	0.00
	5	32.22	16.37	51.39	0.01	0.00	0.01	0.00	0.00	0.00
KR	1	13.51	26.26	11.82	48.41	0.00	0.00	0.00	0.00	0.00
	5	15.75	26.05	11.42	46.69	0.00	0.06	0.00	0.02	0.00

Table 5.15 (cont.)

SG	1	9.90	48.90	0.73	0.17	40.30	0.00	0.00	0.00	0.00
	5	7.65	50.21	1.16	0.86	39.93	0.15	0.01	0.05	0.00
TW	1	14.56	25.42	3.84	7.09	2.98	46.11	0.00	0.00	0.00
	5	15.00	25.38	3.77	6.86	2.97	46.02	0.00	0.00	0.00
ML	1	12.25	19.40	2.04	1.93	3.90	0.65	59.83	0.00	0.00
	5	7.83	22.22	3.37	5.34	4.40	2.10	54.54	0.18	0.00
TL	1	3.81	27.24	0.63	0.63	3.20	0.11	0.98	63.41	0.00
	5	2.58	29.89	1.12	1.82	3.58	0.06	0.85	60.11	0.00
VN	1	9.92	0.32	0.11	0.42	0.04	0.00	0.01	0.05	89.12
	5	7.46	0.78	0.43	1.71	0.01	0.27	0.00	0.25	89.09

More detailed results of the variance decomposition for the emerging markets and advanced markets can be seen in Appendix 5.1.¹⁸

5.3.3.2 Impulse response

The impulse response function is used to investigate the transmission of shocks from one market to other markets in the VAR system. In the tests, we examine the responses of all endogenous markets to a shock in one market. The empirical findings in Table 5.16 indicate the responses of the entire market under consideration. Details of the responses of the emerging and advanced market groups are presented in Appendix 5.2.¹⁹

Overall, the findings in Table 5.16 below document significant influences of the other markets on the innovations of both the Hong Kong and Singaporean equity markets during the entire period, in line with our previous findings on the Granger causality between the two markets. In addition, our results reveal relatively strong responses from Japan, Hong Kong and Singapore to changes in the US. This is partly in line with the findings of Hsiao, Hsiao and Yamashita (2003), who suggest a strong Japanese response to the US over the period 18/9/2001–13/12/2002.

¹⁸ Some important results revealed in Appendix 5.2 are that the variance of Malaysia has a significant endogenous power for the Thai equity market over the entire sample and pre-crisis periods; however, during the post-crisis period, the forecast variance of each market is mostly explained by its owned variances. For the advanced market groups, the results for variance decomposition support for the strong explanatory power of the Hong Kong equity markets to others markets, similar to the findings for VAR decomposition with respect to the entire markets.

¹⁹ The results show that the Vietnamese equity market has lower responses to shocks from Malaysia and Thailand in the entire period and sub-periods. Among the group of advanced markets, our findings do not reveal significant changes compared to the responses of the markets in the entire group.

Table 5.16: Accumulated generalised impulse response among the markets

Innovation in country										
Response of	Period	US	HK	JP	KR	SG	TW	ML	TL	VN
Entire sample period										
US	1	0.0127	0.0054	0.0062	0.0044	0.0048	0.0039	0.0036	0.0030	0.0018
	2	0.0243	0.0136	0.0141	0.0110	0.0127	0.0093	0.0082	0.0083	0.0035
	5	0.0595	0.0357	0.0360	0.0293	0.0355	0.0241	0.0204	0.0226	0.0082
HK	1	0.0067	0.0157	0.0091	0.0093	0.0110	0.0074	0.0066	0.0071	0.0014
	2	0.0137	0.0309	0.0178	0.0191	0.0235	0.0143	0.0132	0.0142	0.0026
	5	0.0341	0.0755	0.0432	0.0474	0.0601	0.0344	0.0319	0.0353	0.0064
JP	1	0.0075	0.0089	0.0154	0.0089	0.0081	0.0065	0.0054	0.0054	0.0025
	2	0.0153	0.0191	0.0305	0.0187	0.0189	0.0134	0.0111	0.0118	0.0045
	5	0.0383	0.0479	0.0749	0.0470	0.0495	0.0328	0.0269	0.0303	0.0099
KR	1	0.0057	0.0098	0.0096	0.0166	0.0095	0.0090	0.0058	0.0063	0.0014
	2	0.0119	0.0199	0.0189	0.0332	0.0207	0.0181	0.0118	0.0135	0.0025
	5	0.0300	0.0488	0.0459	0.0823	0.0534	0.0443	0.0284	0.0347	0.0060
SG	1	0.0049	0.0089	0.0068	0.0074	0.0128	0.0061	0.0063	0.0060	0.0010
	2	0.0101	0.0174	0.0130	0.0145	0.0257	0.0117	0.0123	0.0121	0.0019
	5	0.0259	0.0425	0.0317	0.0358	0.0640	0.0284	0.0299	0.0302	0.0045
TW	1	0.0047	0.0071	0.0064	0.0082	0.0072	0.0151	0.0048	0.0050	0.0010
	2	0.0103	0.0162	0.0139	0.0178	0.0171	0.0306	0.0109	0.0115	0.0019
	5	0.0270	0.0418	0.0350	0.0458	0.0461	0.0761	0.0280	0.0304	0.0044
ML	1	0.0024	0.0036	0.0030	0.0030	0.0042	0.0028	0.0086	0.0032	0.0004
	2	0.0051	0.0082	0.0064	0.0068	0.0099	0.0061	0.0185	0.0074	0.0008
	5	0.0131	0.0215	0.0160	0.0179	0.0270	0.0157	0.0481	0.0202	0.0022
TL	1	0.0034	0.0064	0.0050	0.0054	0.0067	0.0047	0.0053	0.0142	0.0010
	2	0.0075	0.0130	0.0101	0.0116	0.0139	0.0095	0.0114	0.0285	0.0020
	5	0.0197	0.0332	0.0257	0.0305	0.0362	0.0244	0.0296	0.0721	0.0050
VN	1	0.0023	0.0014	0.0026	0.0013	0.0013	0.0011	0.0007	0.0012	0.0160
	2	0.0047	0.0049	0.0067	0.0043	0.0047	0.0039	0.0032	0.0040	0.0355
	5	0.0112	0.0170	0.0201	0.0144	0.0179	0.0137	0.0118	0.0138	0.0965
Pre-crisis period										
	Period	US	HK	JP	KR	SG	TW	ML	TL	VN
US	1	0.0108	0.0046	0.0042	0.0038	0.0040	0.0034	0.0031	0.0022	0.0003
	2	0.0215	0.0092	0.0085	0.0076	0.0081	0.0068	0.0062	0.0044	0.0005
	5	0.0533	0.0231	0.0211	0.0190	0.0211	0.0168	0.0150	0.0113	0.0013
HK	1	0.0057	0.0135	0.0073	0.0077	0.0089	0.0056	0.0052	0.0047	0.0002
	2	0.0115	0.0270	0.0145	0.0154	0.0179	0.0112	0.0102	0.0094	0.0003
	5	0.0286	0.0672	0.0355	0.0381	0.0453	0.0276	0.0249	0.0235	0.0008
JP	1	0.0054	0.0074	0.0137	0.0074	0.0069	0.0051	0.0042	0.0037	0.0010
	2	0.0107	0.0148	0.0273	0.0149	0.0138	0.0102	0.0083	0.0074	0.0021
	5	0.0270	0.0365	0.0674	0.0368	0.0348	0.0249	0.0203	0.0186	0.0052
KR	1	0.0057	0.0093	0.0088	0.0163	0.0089	0.0081	0.0049	0.0054	0.0005
	2	0.0115	0.0184	0.0175	0.0325	0.0178	0.0161	0.0096	0.0109	0.0009
	5	0.0288	0.0454	0.0424	0.0807	0.0453	0.0394	0.0230	0.0272	0.0024
SG	1	0.0043	0.0075	0.0057	0.0063	0.0115	0.0049	0.0050	0.0044	0.0001
	2	0.0086	0.0150	0.0114	0.0125	0.0230	0.0097	0.0100	0.0089	0.0002
	5	0.0219	0.0373	0.0281	0.0311	0.0571	0.0241	0.0251	0.0220	0.0006
TW	1	0.0047	0.0063	0.0057	0.0075	0.0064	0.0152	0.0042	0.0043	0.0004
	2	0.0095	0.0125	0.0111	0.0150	0.0130	0.0303	0.0083	0.0085	0.0007
	5	0.0240	0.0306	0.0264	0.0370	0.0329	0.0749	0.0199	0.0213	0.0019

Table 5.16 (cont.)

ML	1	0.0026	0.0034	0.0027	0.0026	0.0039	0.0025	0.0089	0.0029	0.0001
	2	0.0051	0.0067	0.0054	0.0053	0.0078	0.0049	0.0176	0.0058	0.0002
	5	0.0127	0.0165	0.0128	0.0129	0.0200	0.0118	0.0436	0.0146	0.0005
TL	1	0.0027	0.0046	0.0036	0.0045	0.0052	0.0038	0.0044	0.0134	0.0002
	2	0.0055	0.0092	0.0072	0.0089	0.0103	0.0075	0.0088	0.0267	0.0004
	5	0.0140	0.0228	0.0177	0.0222	0.0256	0.0186	0.0220	0.0667	0.0010
VN	1	0.0004	0.0002	0.0012	0.0004	0.0001	0.0004	0.0002	0.0002	0.0158
	2	0.0005	0.0005	0.0026	0.0009	0.0005	0.0008	0.0002	0.0005	0.0316
	5	-0.0007	0.0024	0.0077	0.0027	0.0031	0.0027	-0.0002	0.0022	0.0787
Post-crisis period										
	Period	US	HK	JP	KR	SG	TW	ML	TL	VN
US	1	0.0130	0.0051	0.0075	0.0048	0.0041	0.0050	0.0046	0.0025	0.0041
	2	0.0255	0.0102	0.0151	0.0101	0.0084	0.0105	0.0092	0.0050	0.0081
	5	0.0606	0.0264	0.0382	0.0292	0.0225	0.0300	0.0238	0.0122	0.0200
HK	1	0.0060	0.0155	0.0092	0.0095	0.0118	0.0095	0.0084	0.0086	0.0027
	2	0.0118	0.0310	0.0184	0.0193	0.0238	0.0193	0.0168	0.0172	0.0054
	5	0.0277	0.0778	0.0462	0.0504	0.0603	0.0502	0.0424	0.0427	0.0133
JP	1	0.0082	0.0085	0.0143	0.0095	0.0075	0.0080	0.0069	0.0054	0.0033
	2	0.0164	0.0170	0.0286	0.0190	0.0150	0.0161	0.0137	0.0108	0.0065
	5	0.0407	0.0426	0.0717	0.0480	0.0376	0.0408	0.0344	0.0270	0.0163
KR	1	0.0042	0.0070	0.0075	0.0114	0.0060	0.0074	0.0057	0.0048	0.0023
	2	0.0085	0.0139	0.0150	0.0226	0.0120	0.0147	0.0113	0.0096	0.0046
	5	0.0220	0.0347	0.0374	0.0554	0.0297	0.0357	0.0281	0.0241	0.0116
SG	1	0.0038	0.0093	0.0064	0.0065	0.0122	0.0074	0.0068	0.0067	0.0016
	2	0.0074	0.0187	0.0127	0.0132	0.0244	0.0151	0.0137	0.0134	0.0032
	5	0.0171	0.0471	0.0321	0.0348	0.0618	0.0395	0.0346	0.0332	0.0078
TW	1	0.0048	0.0076	0.0070	0.0081	0.0076	0.0125	0.0063	0.0048	0.0021
	2	0.0095	0.0153	0.0140	0.0162	0.0152	0.0249	0.0127	0.0095	0.0043
	5	0.0240	0.0381	0.0349	0.0403	0.0379	0.0620	0.0317	0.0239	0.0107
ML	1	0.0022	0.0034	0.0030	0.0031	0.0035	0.0032	0.0063	0.0027	0.0010
	2	0.0042	0.0069	0.0061	0.0066	0.0072	0.0067	0.0126	0.0054	0.0019
	5	0.0090	0.0175	0.0154	0.0182	0.0186	0.0184	0.0319	0.0133	0.0045
TL	1	0.0025	0.0071	0.0048	0.0054	0.0070	0.0049	0.0055	0.0128	0.0010
	2	0.0047	0.0143	0.0097	0.0111	0.0142	0.0101	0.0110	0.0255	0.0020
	5	0.0101	0.0361	0.0246	0.0297	0.0362	0.0272	0.0280	0.0635	0.0047
VN	1	0.0055	0.0031	0.0040	0.0035	0.0023	0.0030	0.0027	0.0014	0.0175
	2	0.0106	0.0062	0.0081	0.0076	0.0048	0.0065	0.0054	0.0027	0.0351
	5	0.0239	0.0163	0.0207	0.0222	0.0133	0.0195	0.0141	0.0064	0.0874

By partitioning the sample of study into the pre-and post-crisis periods, we find all markets react more strongly to a shock in the US during the post-crisis period. In addition, the Hong Kong and Japanese markets display the highest responses to a change in the US market. Interestingly, the response of Hong Kong is higher than Japan during the pre-crisis period, but Japan reacts more strongly than Hong Kong during the post-crisis period. Additionally, we find that Taiwan is likely to be less responsive to shocks compared to the other advanced

markets in the sample. This is in line with Yang and Lim (2004), who examine the response of the East Asian markets during the period 1/1990–10/2000. It is notable that our results suggest a low response of the Vietnamese equity market to shocks from the other markets over the entire sample and sub-periods. This implies that the Vietnamese equity market is isolated from the other markets. Further, among the emerging markets, we find that Thailand is less likely to react to a shock in the US in comparison to Malaysia and Vietnam over the post-crisis period.

In summary, our examination of causal relationships between and among the nine markets shows evidence of interdependence between the Vietnamese and other markets as well as the pairs of other market over the sub-periods. Our findings show evidence in favour of causal relationships (both mono-directional and bi-directional) between pairs of markets. In addition, we also find a multivariate Granger causality among the emerging, advanced and entire markets over the entire period. However, we find significant change in the multivariate Granger causality among the markets during the pre- and post-crisis periods. In other words, we find causality is affected by the GFC as suggested by Glezakou and Mylonakis (2010).

Additionally, the VAR analysis provides evidence of the explanations of variances of one market to other markets as well as the accumulated response of shocks in one market to all endogenous markets in the VAR structure. These findings overall suggest relatively strong responses of all markets during the post-crisis period compared to the pre-crisis period, and the variances in other markets can be explained by the increasing influences of variances in the Hong Kong market.

5.4 Empirical results on contagion among the markets

Similar to Tastan (2006), Chevallier (2011), Chiang, Jeon and Li (2007), Kasch-Haroutounian and Price (2001) and Bollerslev (1990), this thesis assumes that co-variances and correlations between pairs of market returns vary significantly over time. In addition, Forbes and Rigobon (2002) indicate that a correlation between two markets is conditional on market volatilities, particularly during a turbulent period because the correlation may be biased by increases of market volatilities. As such, the model, GARCH model (1, 1) is often employed to measure conditional volatility of individual markets and then the MGARCH model is used to capture conditional correlations of equity-market returns.

In this section, we examine the transmission between pairs of markets under the impacts of the GFC by employing two time-varying correlation tests associated with the constant correlation model proposed by Bollerslev (1990) and the dynamic correlation model proposed by Engle (2002). Specifically, the effects of the GFC on the markets are measured by estimating the dynamic correlation between the equity-market returns of the nine sample markets during the entire sample period and sub-periods. If the dynamic correlation between two market returns significantly increases during the crisis and post-crisis periods compared to that over the pre-crisis period, we conclude that a contagion effect between these markets exists; otherwise, no contagion effect exists.

5.4.1 Volatility of individual markets

As indicated by Corsetti, Pericoli and Sbracia (2005), the correlation between two market returns is not static but varies over time. To capture these time-varying correlations between pairs of markets in the sample, we firstly examine the GARCH (1, 1) model to measure volatilities of the individual market returns. Then, we use the MGARCH model to explore conditional correlations between two market volatilities.

According to the GARCH (1, 1) model, we capture the conditional volatilities of individual market by market innovations caused by old news (coefficients of autoregressive conditional heteroskedasticity or ARCH) and its own lagged market volatilities (coefficients of GARCH) over the entire sample and sub-periods. The results are shown in Table 5.17 below.

Table 5.17: Estimation results from the univariate GARCH model

Market	Equation	Coefficient	Entire sample (2721 obs)	Pre-crisis (2111 obs)	Crisis (130 obs)	Post-crisis (480 obs)
HK	Mean equation	Constant	0.0520**	0.0473**	-0.3225	0.0805
		Constant	0.0127*	0.0106*	1.6310	0.0154*
		ARCH	0.0638*	0.0554*	0.2187***	0.0550*
	Variance equation	GARCH	0.9309*	0.9397*	0.6617*	0.9356*
JP	Mean equation	Constant	0.0358	0.0350	-0.3105	0.0555
		Constant	0.0245*	0.0208*	0.4998	0.0567**
		ARCH	0.0846*	0.0757*	0.2048*	0.0614
	Variance equation	GARCH	0.9068*	0.9159*	0.7619*	0.9078*
KR	Mean equation	Constant	0.1037*	0.1029*	-0.1830	0.1192***
		Constant	0.0198*	0.0243*	0.6457	-0.0033*
		ARCH	0.0711*	0.0726*	0.1144**	0.0095
	Variance equation	GARCH	0.9238*	0.9212*	0.8209*	0.9910*
SG	Mean equation	Constant	0.0592*	0.0499**	-0.2487	0.1011**
		Constant	0.0140*	0.0149*	0.1984	0.0159**
		ARCH	0.0977*	0.0937*	0.0787***	0.0950*
	Variance equation	GARCH	0.8971*	0.8997*	0.8882*	0.8896*
TW	Mean equation	Constant	0.0618*	0.0510**	-0.3062	0.1174**
		Constant	0.0158*	0.0184*	4.4852	0.0172
		ARCH	0.0657*	0.0687*	0.0432*	0.0613*
	Variance equation	GARCH	0.9283*	0.9247*	0.2450*	0.9256*
US	Mean equation	Constant	0.0394**	0.0297	-0.3788	0.1239**
		Constant	0.0117*	0.0089*	0.3915	0.0224**
		ARCH	0.0773*	0.0602*	0.1149	0.1015*
	Variance equation	GARCH	0.9152*	0.9324*	0.8556*	0.8847*
ML	Mean equation	Constant	0.0558*	0.0444*	-0.1058	0.0926*
		Constant	0.0126*	0.0175*	0.2555	0.0116*
		ARCH	0.1154*	0.1308*	0.1752***	0.0799*
	Variance equation	GARCH	0.8755*	0.8582*	0.6649*	0.8883*
TL	Mean equation	Constant	0.0968*	0.0707**	-0.1923	0.1795*
		Constant	0.1592*	0.2689*	1.8210**	0.0414**
		ARCH	0.0906*	0.0952*	0.2438*	0.0954*
	Variance equation	GARCH	0.8266*	0.7515*	0.4791*	0.8805*
VN	Mean equation	Constant	-0.0067	-0.0083	-0.4253**	0.0761
		Constant	0.0192*	0.0191*	0.1374	0.0694
		ARCH	0.2202*	0.2431*	0.2120	0.1378*
	Variance equation	GARCH	0.7993*	0.7831*	0.7738*	0.8416*

Regarding the mean equations, the table show that while the constant terms are all positive during the pre- and post-crisis periods, they are negative during the crisis period. This finding highlights the negative effects of the GFC on the returns of each market in the sample.

In terms of the variance equations, almost all the results indicate statistically significant effects of market innovations caused by news and shocks, resulting in lagged market volatilities on market volatilities. As can be seen in the table, all the GARCH parameters are higher than the corresponding ARCH parameters, suggesting that most markets could self-correct by their own current news. During the entire period, Vietnam is considered the most volatile equity market in the sample because its volatilities are highly influenced by exogenous shocks. Interestingly, all the constants discovered in the mean equations are negative during the crisis period, documenting for declines in the returns of the markets.

5.4.2 Constant conditional correlation

To examine the short-run DCCs among pairs of markets, this thesis first employs the CCC based on the MGARCH (1, 1) model suggested by Bollerslev (1990). The results in Table 5.18 below report CCCs between the Vietnamese equity market and other markets over the entire sample period and sub-periods. The results show that the Vietnamese equity market displays the highest conditional correlations with the US equity market (0.135) and the Japanese equity market (0.122) over the entire sample period. The lowest correlations are found in the relationships between the Vietnamese and Thai equity markets (0.036) and the Vietnamese and Singaporean equity markets (0.039). These findings are not consistent with our previous findings on the unconditional correlations shown in Chapter 3, as the US and Singapore exhibit the lowest correlations with Vietnam over the entire sample and sub-periods, and the highest correlation is discovered in the relationship with Japan.

Regarding the pre-, crisis and post-crisis periods, conditional correlations over the crisis period are higher than those during the pre- and post-crisis periods. The highest correlations are found between Vietnam and the US, and Vietnam and Japan, over the entire sample and sub-periods. This is in line with our previous findings for pair-wise Granger-caused relationships between the pairs of markets. It is notable that the CCC values are higher during the post-crisis period than the pre-crisis period, which may indicate a contagion effect among the markets under the impacts of the GFC.

Table 5.18: Results of the constant conditional correlation between the Vietnamese and other markets

Markets	Entire sample	Pre-crisis	Crisis	Post-crisis
VN–HK	0.063	0.022	0.200	0.184
VN–JP	0.122	0.073	0.421	0.235
VN–KR	0.081	0.042	0.232	0.208
VN–SG	0.039	0.015	0.162	0.108
VN–TW	0.079	0.048	0.243	0.170
VN–US	0.135	0.060	0.488	0.343
VN–TL	0.036	–0.006	0.330	0.172
VN–ML	0.041	0.003	0.302	0.073

The CCC values among pairs of markets are shown in Table 5.19 below. The highest conditional correlations exist between the Singaporean and Hong Kong equity markets over the entire sample and sub-periods. The close relationship between these two markets was already shown in our findings on high unconditional correlation and the pair-wise Granger causality in the descriptive statistics of market returns in Chapter 4. These findings are consistent with the high correlation between Hong Kong and Singapore in comparison to other markets, including the US, Japan, China, Hong Kong, Taiwan, Korea, Singapore, Malaysia and Thailand, as discussed by Yu, Fung and Tam (2010). In addition, the results also indicate that the correlations between pairs of any advanced markets are higher than those between the advanced and emerging markets. This is in line with the findings of Chiang, Jeon and Li (2007), who find evidence of low correlations between the US and emerging markets compared to the correlations between the US and advanced markets. A surprising result is found in the case of Singapore, for which conditional correlations with the US equity market are the lowest among the markets in the sample. This may indicate a relatively weak transmission of shock from the US to Singapore compared to shocks from the other markets.

Table 5.19: Results of the constant conditional correlation between pairs of other markets

Entire period (2721 observations (31/7/2000–31/12/2010))								
	HK	JP	KR	SG	TW	US	TL	ML
HK	1							
JP	0.546	1						
KR	0.592	0.595	1					
SG	0.645	0.493	0.538	1				
TW	0.495	0.455	0.550	0.476	1			
US	0.436	0.444	0.362	0.377	0.333	1		
TL	0.393	0.316	0.353	0.412	0.321	0.229	1	
ML	0.388	0.338	0.346	0.425	0.339	0.319	0.348	1
Pre-crisis period (2111 observations 1/8/2000–29/8/2008)								
	HK	JP	KR	SG	TW	US	TL	ML
HK	1							
JP	0.531	1						
KR	0.583	0.574	1					
SG	0.622	0.487	0.531	1				
TW	0.460	0.414	0.516	0.444	1			
US	0.438	0.407	0.358	0.387	0.314	1		
TL	0.349	0.297	0.307	0.385	0.296	0.294	1	
ML	0.341	0.278	0.327	0.365	0.293	0.220	0.311	1
Crisis period (130 observations 1/9/2008–27/2/2009)								
	HK	JP	KR	SG	TW	US	TL	ML
HK	1							
JP	0.656	1						
KR	0.723	0.712	1					
SG	0.735	0.561	0.707	1				
TW	0.645	0.683	0.727	0.576	1			
US	0.428	0.648	0.397	0.294	0.410	1		
TL	0.588	0.584	0.603	0.640	0.611	0.373	1	
ML	0.651	0.581	0.545	0.673	0.506	0.283	0.587	1
Post-crisis period (480 observations 1/3/2009–31/12/2010)								
	HK	JP	KR	SG	TW	US	TL	ML
HK	1							
JP	0.583	1						
KR	0.600	0.649	1					
SG	0.727	0.503	0.522	1				
TW	0.607	0.569	0.655	0.586	1			
US	0.424	0.543	0.345	0.349	0.389	1		
TL	0.506	0.456	0.453	0.551	0.460	0.411	1	
ML	0.529	0.371	0.400	0.531	0.371	0.222	0.407	1

During the sub-periods, the highest conditional correlation is found between the Singaporean and Hong Kong equity markets, particularly during the crisis and post-crisis periods, when it reaches over 0.7. The lowest conditional correlation exists between the Malaysian and the US equity markets. Interestingly, almost all markets except for Japan display the lowest conditional correlations with the US over the pre- and post-crisis periods. This result supports a lack of influence of the US on the other markets. More importantly, the existence of contagion effects among the markets are confirmed, as almost all of the conditional correlations are higher over the post-crisis period than over the pre-crisis period. This implies a transmission of the GFC from the US to the other markets.

In terms of the groups of markets, it can be seen that both the Hong Kong and Singaporean equity markets exhibit relatively high correlations with the other advanced markets in the sample. In addition, the fact that the US market exhibits the highest conditional correlation with the Hong Kong and Japanese markets over the sub-periods supports the argument that the Hong Kong and Japanese equity markets transmitted the GFC to the rest of the Asian region. In terms of the emerging markets, both the Malaysian and Thai equity-market returns exhibit moderate correlations with the Hong Kong and Singaporean equity-market returns compared to those of other markets, reaching over 0.5 during the crisis and post-crisis periods and 0.35 during the pre-crisis period. Their lowest correlations exist in the relationship between the US and Malaysia at over 0.2. These results are not consistent with the findings of Naoui, Liouane and Brahim (2010), who document higher conditional correlations between the US and Malaysia, and the US and Singapore, compared to the correlations between the US and Hong Kong, and the US and Korea. Our findings also suggest stronger correlations among Hong Kong, Singapore and Japan, whose CCCs are over 0.5, compared to the CCCs found by Tse (Tse 2000), which are below 0.45 (for example, 0.34 for Japan–Singapore; 0.25 for Hong Kong–Japan and 0.43 for Hong Kong–Singapore)

5.4.3 Dynamic conditional correlation

Further study of conditional correlations in this thesis is via the DCC, proposed by Engle (2002) to track correlation evolution between two markets. The results produced by the tests provide graphs tracing the movement of DCC over time in multivariate settings. In this thesis, we examine 36 graphs of the DCC between pairs of market volatilities plotted to describe the time-varying correlations between the nine markets under consideration. Details on the DCC graphs between both Vietnam and the US and the other markets are presented in Figure 5.1

and Figure 5.2 respectively below, while the DCC graphs between the other markets are provided in Appendix 5.3.

Regarding the DCC between market volatilities of the Vietnamese and each of its major trading partners examined in the study, Figure 5.1 shows the correlations ranging from -0.1 to $+0.3$ over the period 2000–2010. Overall, almost all the graphs show a significant increase in the DCC between the Vietnamese equity market and other equity market returns during the crisis period. Some DCC values remain higher during the post-crisis period compared to the pre-crisis period - for example for Hong Kong, Japan, Korea, Taiwan, the US and Malaysia. These findings indicate that the GFC still has some impacts on the linkage of movement between the Vietnamese and these equity market returns after the crisis. Interestingly, the DCC between Vietnam–Singapore and Vietnam–Thailand during the post-crisis period returns almost to pre-crisis levels. These finding may indicate less influence of the GFC on market linkages after the crisis.

An interesting result is found between the Vietnam and US markets: the DCC significantly increases after the crisis, supporting an argument in favour of the transmission of the GFC to the Vietnamese equity market. This result is in line with our previous findings with respect to forecast error variance, which showed the US as the strongest exogenous market in terms of influencing the variances of the Vietnamese equity market. This result is also similar to previous findings by Wang (2011), who reveals positive contagion effects from the US to Vietnam at the time of the subprime mortgage crisis.

Figure 5.1: Results of the dynamic conditional correlation between the Vietnamese and other markets

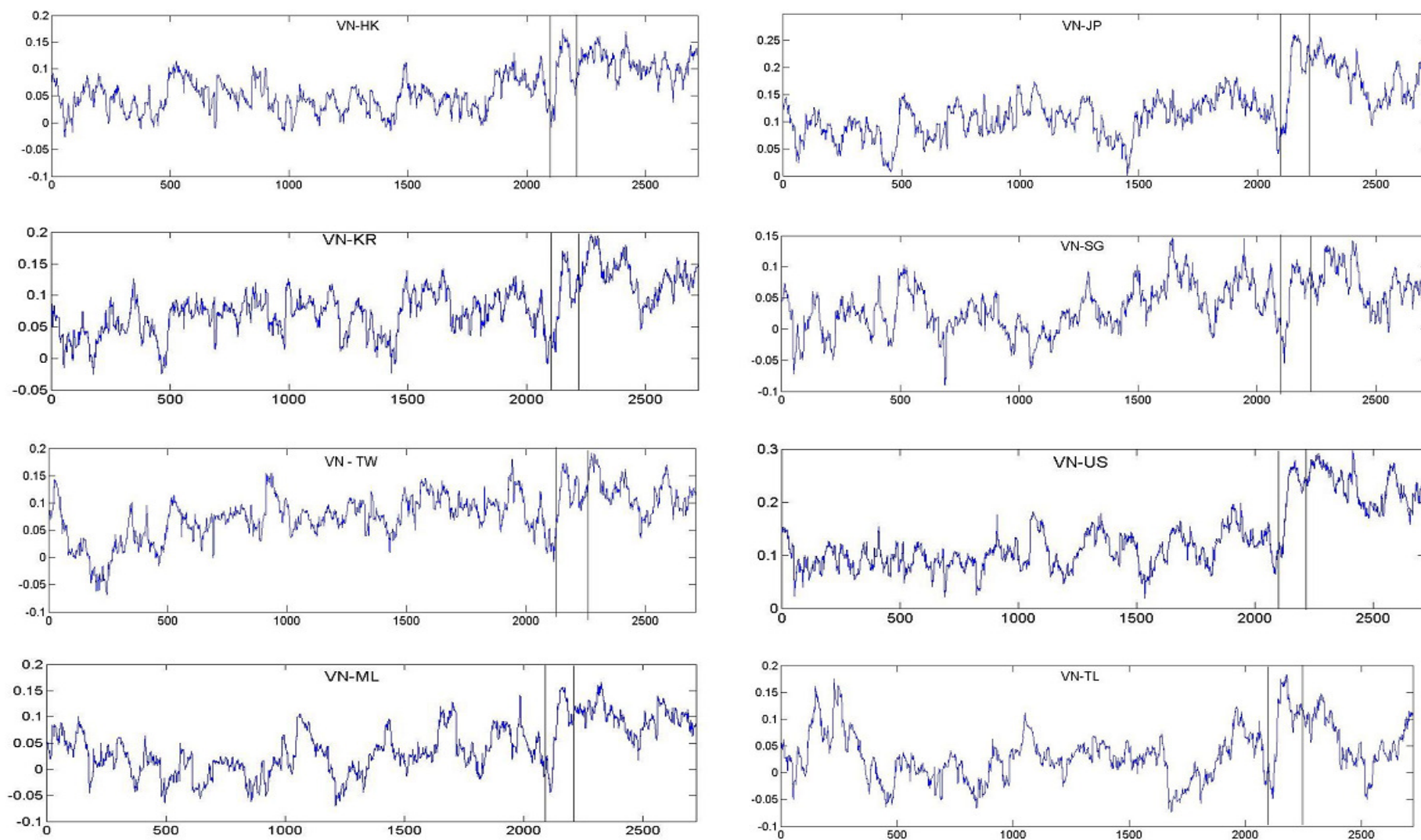
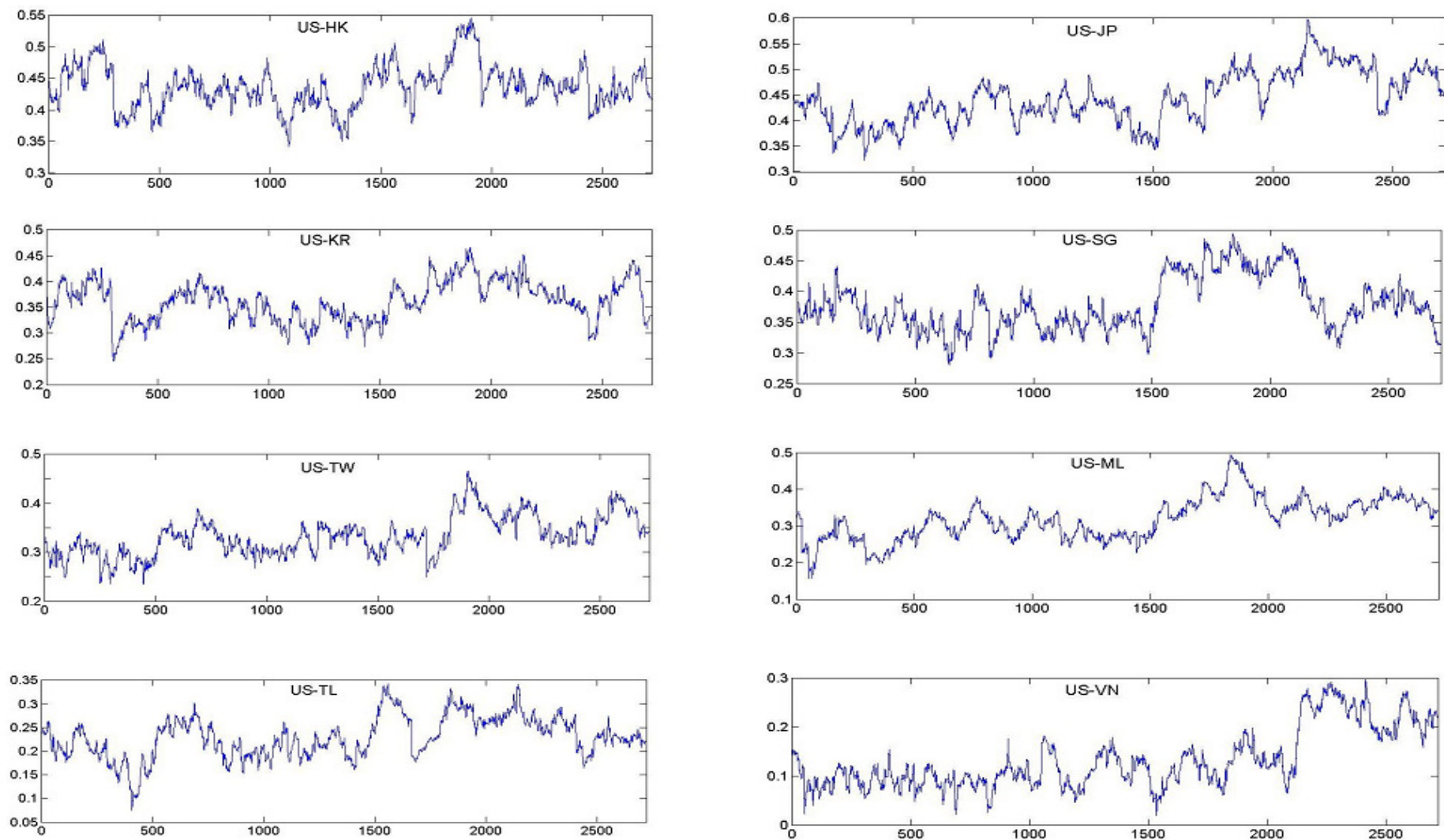


Figure 5.2: Results of the dynamic conditional correlation between the US and other markets



The GFC was known to originate from the US and then transmitted to the global market. As such, this thesis examines the DCC between the US and the selected equity markets in the sample. The results can be seen in Figure 5.2 above. In general, the DCC between the US and advanced equity-market returns ranges from 0.2 to 0.6 higher than DCC value between the US and emerging returns, spanning from 0 to 0.35. In addition, the DCC between the US and other markets reaches relatively higher values during the crisis period, while some do not change significantly - for example, between the US and Hong Kong, Taiwan, Korea, Malaysia and Thailand - or follow a downtrend - for example, US–Singapore. It is notable that some graphs support the premise of a contagion effect in the early half of 2008, since the DCC significantly increases over that period - for example, from the US to Hong Kong, Taiwan and Malaysia. This finding may support the transmission of the GFC to some equity markets under consideration from as early as July 2007 (Cai, Chou and Li 2009; Glezakou and Mylonakis 2010; Naoui, Liouane and Brahim 2010; Chakrabarti 2011), instead of the crisis defined previously in the thesis (that is, beginning September 2008). These results are in line with the argument of Chevallier (2012), who supports a different period for the transmission of the GFC to the global equity market.

With regard to the other equity markets being considered, the graphs in Appendix 5.3 report the DCC between pairs of markets and demonstrate how a shock resulting from the GFC transmits to the selected global equity markets in the sample. Interestingly, some graphs support for the significant transmission of the GFC from the period September 2008–February 2009 (Singapore–Thailand), while others support for the transmission from July 2007–September 2008 (Taiwan–Thailand, Taiwan–Malaysia, Singapore–Taiwan, Hong Kong–Thailand, Hong Kong–Singapore and Hong Kong–Japan) and some display at yet different periods of time (Hong Kong–Taiwan; Hong Kong–Korea). These significant changes in the dynamic correlation not only illustrate the impacts of the GFC on each country but also its consequences associated with government rescue plans in response to the GFC across the countries. The results are in line with the report of the International Monetary Fund (2010a), which argues that different countries followed different paths to recovery as a result of different policy responses. The findings overall provide support for increasing correlations between pairs of markets over the period 2007–2008.

In summary, empirical estimations using the CCC and DCC models provide evidence in favour of the transmission of the shock originating from the US towards the Vietnamese equity market and other Asian equity markets. The results also show that the GFC has affected each market differently because their conditional correlations significantly change over the pre-crisis, crisis and post-crisis periods. Moreover, the fact that all conditional correlations significantly increase during the GFC indicates a contagion effect among the markets. While our findings are in line with the findings of Yiu, Alex-Ho and Choi (2010) on the contagion among global equity markets during the GFC, they are not consistent with the findings by Samarakoon (2011), who does not find supporting evidence for a contagion effect from the shock in the US to global markets. The difference in these findings could be the result of different research methods employed.

5.5 Chapter conclusion

This chapter investigates the effects of the GFC on the linkages between the Vietnamese equity market and its eight major trading partners as well as among the markets over the period 2000–2010. The three main relationships taken into account in the thesis are long-run relationships, causal relationships and contagion effects. The three empirical testing models employed are co-integration, causality and contagion tests. The pre- and post-analysis technique is used to analyse the effects of the GFC on the linkages

For long-run relationships, both bivariate co-integration tests based on the residuals model and co-integration tests with the presence of structural breaks reveal less evidence of long-run co-movements between the Vietnamese and other markets over the post-crisis period compared to the pre-crisis period. Alternatively, co-integration tests based on the VAR model show that several co-integrating vectors existed in the relationships between the Vietnamese and advanced markets during both the pre- and post-crisis periods. Given these inconsistent results for the bivariate co-integration tests, it was not possible to confirm the existence of a bivariate co-integration relationship between pairs of markets. However, the different empirical findings during the pre- and post-crisis periods support significant effects of the GFC on the long-run relationships between the markets under investigation. In addition, the results reveal that a lack of evidence of the co-movement among the three emerging markets is documented over the entire sample period and sub-periods, suggesting different directions among the markets in the long run. These results could be explained by the markets' differences in degrees of integration. We find that one co-integrating vector existed during pre- and post-crisis periods among the advanced markets and all markets groups, except for

two co-integrating vectors discovered among entire markets over the entire period and pre-crisis period. Thus, we may conclude that the long-run relationships between and among the Vietnamese equity market and other selected markets vary differently under the impacts of the GFC. These findings are in line with findings by Cheung, Fung and Tsai (2010), who document dramatic changes in the long-run relationships among global markets before and after the GFC.

With respect to causal relationships, our empirical results show evidence of both mono- and feedback-directional relationships between pairs of markets, and moreover, these relationships change over time. An interesting revelation is in the relationship between Vietnam and the US, as the markets are not Granger-caused during the pre-crisis period but during the post-crisis period, the leading role of the US is revealed. In contrast, the US equity market is shown to be a leading market among the other markets, since it has an influence on all the examined markets after the crisis period. These results are in line with previous findings on the dominant influence of the US in the global market (Shabri Abd. Majid, Kameel Mydin Meera and Azmi Omar 2008; Cheung, Fung and Tsai 2010; Glezakou and Mylonakis 2010; Huyghebaert and Wang 2010). In addition, the results provide evidence of the presence of multivariate Granger causality among the markets during the pre-crisis period, supporting a leading role for Malaysia among the emerging markets as well as Singapore and Japan among the advanced markets. However, short-run relationships are not found among lagged values of market returns over the post-crisis period, except the significant effects of the co-integrating vectors and constant terms. Our explanation for these results is the relatively short time frame of the post-crisis period examined in the thesis in comparison with the pre-crisis period.

Finally, with respect to contagion effects, the results show that the volatilities of all equity markets under observation are generally more influenced by their self-corrections than old news; however, during the crisis period, the role of old new is more significant compared to during the pre- and post-crisis periods. In addition, we find that both Japan and Hong Kong display the highest conditional correlations with the US over the entire sample and sub-periods, suggesting their crucial roles in spreading the GFC to the other markets in the sample. Moreover, the DCCs show the empirical findings supporting the strong impacts of the GFC on the linkages between the US and Vietnam, as their time-varying correlations remain higher after the crisis compared to the pre-crisis and crisis periods. Further, due to the significant increases in both the constant and DCCs between pairs of markets during the crisis period, the empirical results demonstrate the transmission of shock originated from the GFC

to the selected markets, including Vietnam. This finding is in line with Wang (2011). In addition, the empirical findings are consistent with Syllignakis and Kouretas (2011), who document empirical evidence of the transmission of the GFC to global markets.

Chapter 6: Conclusions and Recommendations

6.1 Overview

The world economic and financial system has become increasingly integrated over recent decades as a result of rapid expansions of international trade, services and finances. This increased integration suggests investment opportunities for investors in both domestic and international equity markets. However, the question of whether diversification of international markets always reduces risks for investors, particularly when global markets tend to move together during periods of crises, is a pertinent one. In addition, global equity-market linkages are of interest to many researchers because they reflect interaction among the markets.

There is a vast quantity of research on equity-market linkages in the literature. Empirical results generally show that equity-market linkages vary depending on examined markets and periods of study. In addition, market linkages are also found to be subject to change if there is a serious event such as terrorism or a crisis. A wide range of studies document the significant impacts of the 1997 AFC, the 1998 Russian crisis and the 1999 Brazilian crisis on global market linkages. However, the impacts of the GFC on linkages are still being debated.

Although known as a young and thin market, the Vietnamese equity market experienced sharp declines over the 2007–2008 GFC period. The market was considered one of the worst-performing markets in the world in 2008. This raises a concern as to what extent the GFC has influenced the Vietnamese equity market and its market linkages to the global equity markets. Studies on the Vietnamese equity market are sparse in the existing literature and there is a lack of research taking into account the influence of the GFC on the market as well as on its cross-market linkages. Thus, the primary objective of this thesis is to investigate the effects of the GFC on the Vietnamese equity market and its global market linkages.

In this thesis, different research techniques have been employed to analyse the impacts of the GFC on the Vietnamese equity market. In addition, a series of econometric models, including the co-integration (a long-run linkage), causality (a short-run linkage) and contagion (a transmission of a shock caused by the GFC) models, have been used to examine the effects of the GFC on the cross-market linkages of Vietnam and its eight major trading partners over the period 2000–2010. The impacts of the GFC on equity-market linkages are taken into account

by separating the empirical findings into the pre- and post-crisis periods. Extensive analyses and discussions of these linkages are presented in chapters 3 and 5.

This chapter provides conclusions of the major findings discussed. In addition, it proposes policy implications and suggests further research directions withdrawn from the limitations of the thesis. Section 6.2 summarises the major findings with respect to the influences of the GFC on the Vietnamese equity market and its linkages to global equity markets. Section 6.3 provides policy implications for policy-makers, State-Bank officers and fund managers. The limitations of the thesis and further research directions are discussed in sections 6.4 and 6.5 respectively.

6.2 Summary of major findings

With regard to the primary research objective and associated research questions proposed in this thesis, this section summarises the major findings in the following sections.

6.2.1 Vietnamese equity market, pre- and post-Global Financial Crisis

It is well known that the Vietnamese equity market followed the downward trend of the global equity market during the GFC. However, to gain a deeper understanding on the impacts of the GFC, the first research question in the thesis examined to what extent the GFC affected the Vietnamese equity market. This question was addressed broadly in relation to the market environment. Specifically, impacts of the GFC on the market are described in relation to three issues which are market regulation, market developments and the investor base. In addition, critical factors in the market environment that may affect its linkages to global equity markets are discussed.

The Vietnamese equity market is known as a very young market because of its short history and relatively small size compared to regional and global markets. The market has achieved impressive progress in the last decade; however, it experienced serious negative effects from the GFC. Therefore, significant changes in the market regulations before and after the crisis are carefully analysed in this thesis. The thesis has documented the high degree of involvement of the Vietnamese government and the heavy intervention of the State Bank in the market regulations during the crisis and post-crisis periods, and it is argued that several trading regulations issued by the market authorities over the periods are incentive-based policies.

Contradictory to the impressive progress over the period 2006–2007, the Vietnamese equity market was deeply influenced by the GFC from 2008. Market capitalisation had declined over 60 per cent by the end of 2008 compared to the highest value in early 2007. Although the market index and market trading value have increased slightly since the crisis, listing activity remains quiet. These findings imply that performances of public firms in the markets have been severely affected by the GFC.

The investor structure of the Vietnamese equity market was confronted with significant changes under the effect of the GFC. Before the crisis, the number of trading accounts and the trading values of foreign investors increased significantly, suggesting increasing integration of the market. However, when the crisis occurred, foreign investors became hesitant to invest in the market and their trading values declined sharply. The thesis also identifies foreign investors as leaders in the market while domestic investors are new, inexperienced and followers.

Market-environment factors are often viewed as a source of equity-market linkages. Several critical factors in the market environment of the Vietnamese equity market related to market returns are documented in the thesis, including fundamental factors, market regulations and information, and investor behaviour. However, research on the Vietnamese equity market is sparse so our analyses of the impacts of these factors on the markets, as well as cross-market linkages, are somewhat limited.

6.2.2 The co-integration relationship among the markets

The second research question addressed in the thesis is whether long-run linkages exist between and among the Vietnamese and other selected equity markets and, if they do, whether these linkages have changed under the impacts of the GFC. These questions were answered by employing three types of bivariate co-integration tests - based on residuals; allowing for structural breaks; and based on the VAR model—to examine the linkages between pairs of markets. We then employed multivariate co-integration tests based on the VAR model to investigate the long-run linkage among the groups of markets.

With respect to the bivariate co-integration relationships, we found that the long-run co-movements are statistically significant in the relationships between Vietnam and both Hong Kong and the US, which are often known as leading markets in the regional and global markets. In addition, almost all of the long-run relationships found in the thesis are mono-directional linkages from the advanced markets to Vietnam. This implies that the Vietnamese

equity market is influenced by the advanced equity markets in the sample. These findings suggest co-integration between the Vietnamese and global markets in the long-run.

The results of the three bivariate co-integration tests between pairs of the other markets in the sample support evidence of long-run relationships, particularly among the Asian markets. Much evidence of co-movements is found in the case of Taiwan. Notably, our empirical findings show that Japan does not co-move with any markets in the sample in the long-run during the entire period. Similarly, less evidence of co-movements is found in the case of the US and Korea. This could be explained by differences between the degrees of financial integration between the markets. Our findings are in part consistent with previous results by Huang, Yang and Hu (2000), who find no evidence of co-integration between Japan, Hong Kong, Taiwan and the US over the period 1992–1997, and Leong and Felmingham (2003), who find no evidence of co-integration between Japan, Singapore, Hong Kong and Korea in the 1990–2000 period. A summary of the three bivariate co-integration tests between the Vietnamese and other markets as well as between pairs of the other markets is shown in Appendices 6.1 and 6.2 respectively.

It is noteworthy that our empirical findings on the three bivariate co-integration tests reveal inconsistent results. This again confirms the unclear evidence in the bivariate co-integration models as discussed by Fernández-Serrano and Sosvilla-Rivero (2001) and Gupta and Guidi (2012).

Regarding the multivariate co-integration relationship, our findings show that there is no significant change in the long-run movement among the markets. Specifically, we found some evidence of the long-run co-movement among the advanced and entire markets, but a lack of long-run relationship among the emerging markets. A possible explanation for the lack of relationship among the emerging markets is that these are small markets with restricted market environments in terms of global integration; thus, they may follow different directions in the long run. Our results are in part in line with previous studies that report one co-integrating vector existed among several markets such as Hong Kong, Singapore, Korea, Taiwan and Japan over the period 7/1990–6/7/2000 (Leong & Felmingham 2003) and Hong Kong, Taiwan, Japan and Korea over the period 2/9/2008–31/8/2009 (Assidenou 2011). However, our findings extend the previous studies by not only including emerging markets in the sample but also examining the co-integration relationship among different groups of markets (that is, advanced and emerging markets).

6.2.3 The causal relationship among the markets

The third research question is associated with short-run relationships between and among the markets under observation. The question was raised as to whether interdependence exists in the relationship between and among the Vietnamese and global equity markets and, if yes, how the linkages changed under the effect of the GFC. This question has been addressed by employing the causality tests to examine the lead-lag relationships between and among the markets. Both the bivariate and multivariate Granger causalities between the Vietnamese and other markets are investigated. In addition, a further analysis based on the VAR model is taken into account to examine the response of one market to a shock in other markets and the predictability power of forecast error variance of each market explained by other markets. The bivariate causal relationships overall are significantly found, suggesting for the short-run linkages among the markets.

Specifically, between markets the feedback causalities are found in the relationships between Vietnam and Singapore, Korea and Japan. These results are not surprising because these countries have close relationships with Vietnam in terms of international trades and finance. However, our findings reveal a lack of short-run linkages between the Vietnamese and US equity markets. It can be concluded that the Vietnamese and US equity markets follow different directions in the short run; however, they co-move in the long run. In addition, we find only mono-directional relationships from Thailand and Malaysia to Vietnam. These findings imply that the short-run movements of the Vietnamese equity market are influenced by all the markets in the sample except the US. In addition, we find that both the leading and lagging roles are reported in the relationships among the other markets in the sample, supporting their strong short-run linkages.

With regard to the multivariate Granger causality, the Malaysian equity market demonstrates a leading role among the emerging markets while both Singapore and Japan are found as leading markets in the advanced and entire groups. Interestingly, Vietnam and Thailand are reported as lagging markets over the entire sample period.

In terms of the VAR analyses, we find a minor role for the forecast error variance of the other selected markets to the Vietnamese markets. In addition, Vietnam is documented as isolated from shocks in other markets, as its market returns are also self-corrected. The findings imply a weak causality linkage between the Vietnamese and the selected markets.

To sum up, interdependence between and among the Vietnamese and other markets in the sample is widely found in the thesis except for the linkage with the US. This suggests short-run linkages between the Vietnamese and regional markets. However, Vietnam is still isolated from the US in a short-run linkage. In addition, among the entire markets, we find that the leading roles of Singapore and Japan in the sample are strongly confirmed.

6.2.4 Impacts of the GFC on equity-market linkages

Our findings show that the long-run relationships change significantly over the sub-periods. Specifically, only Japan and Taiwan reveal evidence of co-movement with Vietnam during the pre-crisis period, while no significant evidence appears during the post-crisis period (see Appendix 6.1). In addition, long-run linkages between Vietnam and both the US and Hong Kong are reported only during the entire sample period and not during the sub-periods. This highlights a probability of different directions over shorter periods of study between these markets.

Effects of the GFC on co-integration among the pairs of other markets are shown in Appendix 6.2. Evidence of a long-run relationship is found during the post-crisis period compared to those during the pre-crisis period. This can be explained by the relatively similar strategies among the markets towards their recoveries after the crisis. In addition, the results provide support for the leading roles of both the Taiwanese and Thai equity markets for the other markets during the post-crisis period. This finding implies that the emerging economies will recover from the crisis sooner than the advanced economies.

However, we do not find completely consistent evidence among the three bivariate co-integration testing models during the pre- and post-crisis periods. Therefore, we cannot strongly conclude for any long-run relationship between the Vietnamese and other markets during the sub-periods.

In terms of the long-run linkages among the markets, we find evidence of the co-movement only among the advanced and entire markets over the pre- and post-crisis periods. However, no evidence of long-run linkage is revealed among the emerging markets. These findings are consistent with our results over the entire sample period. They imply that the GFC did not strongly affect long-run linkages among the groups of markets. However, only one co-

integrating vector existed; thus, opportunities remain for investors to diversify their investment portfolios among the markets.

In terms of the causal relationships, the GFC overall exhibits significant impacts on the short-run linkages between Vietnam and the US. Before the crisis, no causal relationship existed between Vietnam and the US; however, after the crisis, a mono-directional relationship is found from the US to Vietnam. Another interesting result is found in the relationship between Japan and Vietnam. During the pre-crisis period, the Vietnamese equity market affects the Japanese market; however, this relationship reverses after the crisis.

Significant changes in the causal linkages are also found in the relationship between the pairs of other markets over the GFC period. More specifically, while the US exhibits both a leading and a lagging role towards the other markets before the crisis, it is significantly influenced by almost all the markets except Vietnam during the post-crisis period. Interestingly, we find the Singaporean market taking a leading role for all the other markets in the sample during the crisis period.

Taking into account the multivariate Granger causality, we find similar evidence of causal linkages among the examined markets over the pre-crisis period (for example, a leading role for Malaysia in the emerging-market group and for Singapore in the advanced- and entire-market groups). However, only causal linkages among the ECTs and constant terms are reported among all three groups during the post-crisis period. This means that the causal linkages among the markets in the post-crisis period are adjusted by long-run co-integrating vectors rather than lagged values of endogenous variables in the dynamic structure. We explain these findings with caution by giving two interpretations. Firstly, the findings may be due to our parsimonious criterion in selecting the lag length for the VAR model (the lowest value of the SIC and AIC). Second, the period of study over the post-crisis period (1/3/2009–31/12/2010) is relatively short compared to that over the pre-crisis period (27/8/2000–31/8/2008). This suggests that a multivariate causal linkage among the markets should be performed in further research by using another lag-length selection criterion and extending the period of study after the GFC.

Additionally, the VAR analysis also confirms the impacts of the GFC on the linkages between Vietnam and global markets, as we found that while Vietnam is more influenced by a shock from Hong Kong and Japan before the GFC, after the GFC the Vietnamese equity market is highly affected by a shock from the US.

To sum up, by partitioning the study sample into the pre- and post-crisis period, we find that both long-run and short-run linkages between the Vietnamese and other selected markets vary over the periods. The Vietnamese equity market integrates into the regional and global leading markets in the long run; however, their movements in the short run follow different directions. In addition, evidence of significant changes in both the long-run and short-run linkages among the examined markets confirms the impacts of the GFC on global-equity markets.

6.2.5 The contagion relationship among the markets

The issue of the transmission of shocks through equity-market linkages is raised in the thesis by questioning whether a shock was transmitted from the GFC to the Vietnamese equity market and other selected markets and, if yes, how and where the shock originated. To address the issue, the thesis employs the GARCH (1, 1) model to estimate the volatility of the individual markets, and then investigates how time-varying correlations between the pairs of markets change over the pre- and post-crisis periods to document the contagion effects. Both the CCC and the DCC are examined.

The results indicate significant impacts of both current news and shocks from old news on the volatility of each market. It also suggests that all the markets could self-correct by old news on their market volatilities. In addition, significant changes in the market volatilities of all markets appear in the crisis period, suggesting for the higher volatility of the markets during the period. Further, the highest volatilities are found in the Vietnamese equity markets, as its volatilities are highly influenced by exogenous shocks.

In the CCC analysis, contagion effects are found in the relationships between the Vietnamese and other markets, as the CCCs are slightly higher after the crisis compared to those before the crisis, suggesting for the transmission of shocks through the linkages.

Interestingly, before the crisis, the highest CCC is found in the relationship between Vietnam and Japan; however, this switched to the relationship between the US and Vietnam during the crisis and post-crisis periods. This implies a strong linkage between the market volatilities of Vietnam and the US after the GFC, supporting for the significant transmission of the shock from the US to Vietnam.

The significant change in the CCCs between the US and other markets during the sub-periods document how the shock is transmitted among the markets. In particular, among the markets in the sample, Japan appears to be the first market influenced by the crisis, which is then transmitted to Hong Kong and Taiwan. Both Singapore and Malaysia are considered less influenced by the GFC during the crisis.

Similar findings are generally found in the DCC analysis because almost DCCs of the pairs of markets are higher after the crisis than before the crisis. The findings also highlight a transmission of the shock among the markets. In addition, the significant changes of DCCs before and after the GFC are found in the emerging markets. This suggests a significant impacts of the GFC on the emerging markets.

Interestingly, Hong Kong is found to be the market that experienced the highest DCCs. This suggests stronger linkages between Hong Kong and other selected markets. Further, among the DCC of the US and other markets, the highest correlation is found with Hong Kong during the pre-crisis period, but it switched to Japan during the post-crisis period. This finding implies that Japan plays an important role in transmitting a shock from the GFC to the Asian markets.

There is a common trend in the DCCs between the Vietnamese and other markets: the correlations are relatively higher after the crisis than before the crisis. A significant increase is found in the relationship with the US, implying a loss of diversification benefit for investors who diversify their investment portfolio by investing in both the markets after the GFC. In addition, the finding suggests for strong impacts of the GFC in the Vietnamese market.

Interestingly, Singapore is found to be the first market among the examined markets influenced by the GFC. The GFC transmitted to Singapore in early 2007 and remained until early 2008. The crisis was then propagated to the advanced markets in early 2008. Finally, it reached Vietnam and Japan in the second half of 2008. These findings demonstrate the different periods of time that the GFC affected the global markets.

In brief, the empirical findings support for a transmission of the GFC to the Vietnamese and other markets. In addition, the findings demonstrate the transmission of the shock among the markets.

6.3 Policy implications

Based on the findings of the impacts of the GFC on the Vietnamese equity market as well as the empirical results of the linkages between the Vietnamese equity market and its trading partners, the thesis suggests several recommendations to policy-makers, State-Bank officers and fund managers in Vietnam.

The thesis highlights the significant impacts of the market environment under the GFC in terms of fundamental factors, market regulations and information, and investor base. The empirical findings however also indicate several limitations concerning the linkages between the Vietnamese equity market and selected global equity markets. Therefore, to strengthen the Vietnamese equity market towards more global integration, policy-makers should take into account a more liberal policy approach as follows:

- The current high level of government involvement in the market should be gradually eliminated. This could include the removal of regulations on the limited proportion of foreign ownership of listed firms; permission for major foreign-owned firms to be listed in the market; and the elimination of price-change limit regulations.
- Information in the market should be transparent with clear regulations ensuring that information is widely available to all participants in the markets.
- The Vietnamese government should follow the international investment agreements to promote the tighter linkages of the Vietnamese equity market with global equity markets.
- The Government should take into account reforms on insider trading and curb speculation and to strengthen market operations.

State-Bank officers should learn from the effects of the GFC in order to better monitor the market in the future via quick responses and appropriate monetary policies. This will help to lessen the effect of crises.

Linkages between and among global markets are another issue that policy-makers should consider. This thesis documents different levels of market linkages, including both long-run and short-run linkages, between pairs and groups of markets. We recommend that policy-makers take into account international policy linkages, especially those markets that exhibited strong linkages with Vietnam. The findings are important for international fund managers who want to diversify their investment portfolios in the global-equity markets including Vietnam.

The high volatility of market returns and significant changes in the volatility of market linkages of the Vietnamese and other selected markets during the vulnerable period are other issues that both policy-makers and fund managers can consider in the light of this thesis. In particular, policy responses to crises should be quick and clear to avoid a speculative tendency in the market during crisis periods. Market information should be enhanced to avoid the instability of investor behaviours. Empirical findings with respect to the interrelationship of market volatilities between the Vietnamese and global markets are also of great benefit for fund managers who want to diversify their investment portfolios during a period of turmoil.

In conclusion, the thesis documents a wide range of market linkages between and among the Vietnamese and other markets during the pre- and post-crisis periods in terms of market levels, market returns and market volatilities. It highlights the importance of enhancing the market environment and market information in the Vietnamese equity market, and suggests taking into account the international-policy linkages. The findings also provide useful information for fund managers to diversify their investment portfolios in global equity markets including the Vietnamese equity market.

6.4 Limitations

Although this thesis has thoroughly answered the research questions proposed, it has some limitations. Firstly, the impacts of the GFC on the Vietnamese equity market are generally studied with some consideration of significant changes in the market environment during the pre- and post- crisis periods. An analysis of the effects of the GFC on an industrial level would be of interest; however, such an analysis cannot be undertaken currently due to a lack of data and opaque market information.

As Vietnam is a young market with a relatively short history, the time series data used in the thesis (28/7/2000–31/12/2010) is not long enough to examine the impacts of other crises on the Vietnamese equity market in order to compare and contrast with the current findings. In addition, the GFC occurred in recent years; thus, the time series data available to examine the impacts of the GFC after the crisis is relatively short (1/3/2009–31/12/2010). This may have an effect on the reliability of the results, particularly during the post-crisis period.

To examine the impacts of GFC on equity-market linkages, the pre- and post-analysis approach is used. However, the approach implicitly has certain limitations in determining breaking dates of the market data. Although the results are not biased, the approach does not take into account regime shifts by individual market and market linkages as a result of the GFC.

In addition, there are also some limitations with regard to the research methods employed in the thesis. Firstly, the co-integration test allowing for structural breaks deals with only one break in the data, while in the context of global markets, more than one break in the time series data of an individual market may be possible. Second, the analysis on the transmission of shocks does not take into account the asymmetric volatility in an individual market that may cause some changes to the results on contagion effects. Finally, the thesis examines the linkages in nine equity markets that include many emerging and developing markets that are different with respect to their environments and developments. Thus, our explanations of empirical findings are somewhat limited because not all market-related aspects - such as individual market regulations or government responses to the GFC - could be taken into consideration due to the scope of the thesis.

6.5 Recommendations for further research

The GFC severely influenced global markets and caused significant changes in market linkages. In the body of literature, a wide range of empirical studies on equity-market linkages are examined in the context of advanced markets, while studies on emerging markets - especially a young and thin market like Vietnam - are limited. However, due to the unavailability of sectoral data and a lack of information transparency in the Vietnamese equity market, the thesis examined the impacts of the GFC in the market environment and its global market linkages. It sheds light for a further study addressing the impacts of the GFC on the market at the sectoral and investor-behaviour levels by using a survey or an interview. Findings may provide clearer explanations of the impacts of the GFC in a thin and young market.

The thesis highlights the importance of the market environment in the Vietnamese equity market, with its high level of government involvement and lack of information transparency. Thus, the thesis recommends a further study that quantitatively analyses the impacts of market-environment factors on the market returns of Vietnam considering the pre- and post-GFC periods.

Due to the short time series data collected after the GFC, the empirical findings on the multivariate equity-market linkages are limited. Therefore, we recommend a replication study of the investigations and testing approaches with an extended period of study post-GFC.

In the research methodology used in the thesis, almost all the empirical models are restricted because they do not take into account breaks in time series data except the bivariate co-integration tests, which allow for one break. Further research could address this by employing other empirical models associated with regime shifts in time series data, such as the co-integration with multiple regime shifts or Granger-caused, allowing for the presence of structural breaks.

The contagion effects examined in the study are based on a definition of significant increases in correlations between two markets after the crisis compared to those before the crisis. The empirical techniques based on the CCC and DCC-MGARCH analyses clearly suggest for the transmission of the crisis. However, there are several research methods that could be used to investigate the contagion effects using different definitions of contagion; the findings of such studies may suggest further research of contagion effects among the markets.

Finally, the empirical findings of the thesis mostly examined these linkages in the context of market levels between pairs of markets or among groups of emerging, advanced and entire markets. Thus, further studies examining long-run linkages, short-run linkages and contagion impacts at a sectoral level among the markets are important.

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Appendices

Appendix 2.1: Timeline of events during the Global Financial Crisis

Period	Major events
January 2007–July 2007	US financial institutions announced for losses linked to the mortgage investment in the US.
August 2007–December 2007	The US Government committed for bankruptcy protection to mortgage investments. Financial institutions continued reporting huge losses linked to the US mortgages.
January 2008–March 2008	The US Government announced a stimulus plan to prevent business slowdown.
April 2008–August 2008	Financial institutions reported big losses. The US Government requested Government-agency support for two of the largest federal mortgage institutions ('Fannie Mae' and 'Freddie Mac').
September 2008	Fannie Mae and Freddie Mac were taken under Government conservation. Lehman Brothers filed for bankruptcy protection. Two investment banks (Goldman Sachs and Morgan Stanley) were approved to become traditional commercial banks.
October 2008	Financial institutions in global markets reacted by going into recession. Global markets suffered severely from the shock of the crisis. European governments attended discussions on the crisis. A series of monetary policies were announced by European governments to deal with crises (for example, rescue plans, interest-rate cuts). International organisations announced massive rescue plans for Hungary, Greece, Turkey, Ukraine and Ireland.
November 2008–February 2009	Governments announced plans and actions to rescue their economies from the financial-market instability.

Source: Adapted from Bartram and Bodnar (2009)

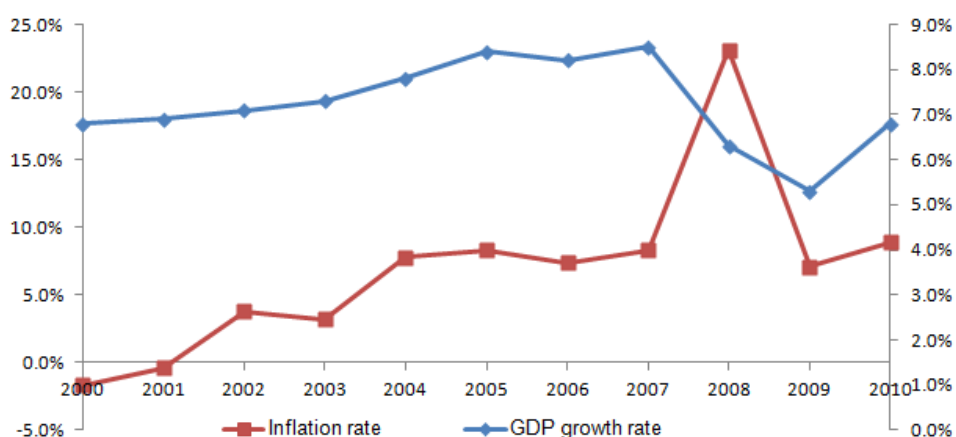
Appendix 3.1: Overview of the Vietnamese Economy

Following the “Doi moi” process in 1986, Vietnamese economy has experienced a relative macroeconomic stability, however, its linkages to the rest of the world were largely limited (Arkakie and Mallon 2003). Notably that since the early years of the 21th century, the country has achieved significant results towards the globalization process, for instance signing the Bilateral Trade Agreement with the United States in 2001; successfully organizing the Asean Pacific Economic Cooperation Conference in 2006; and becoming an official member of the World Trade Organization in 2007. In order words, the economy has gradually broadened and intensified the international economic relations. Some significant achievements of the economy are indicated over the last ten years as follows:

Economic growth and inflation.

Over the last 10 years, the Vietnamese economy has experienced relatively the high economic growth rate at over 7% and the highest GDP growth rate achieved 8,5% in 2007 (World Bank 2012). In the meantime, the inflation rate gradually increased in the first half of the decade and went dramatically up to 22.4% by the end of 2008 (see Figure A3.1 below). The significant changes can be explained by impacts of global financial crisis and the fluctuation of global crude prices and food commodity prices (Euromonitor 2009). Recently, the GDP growth rate of the country has recovered slightly proving for its economic recovery.

Figure A3.1. GDP growth rate and Inflation rate over the period of 2000 – 2010



(Source: World Bank 2012)

Regarding the structure of GDP, as depicted in Table A3.1 below, both industry and services are two sectors that fuelled the GDP growth rate (Asian Development Bank 2012). Between 2000 and 2007, the industry sectors contributed to over 36%. The percentage of agricultural output slightly decreases, maintaining about 20%. It could be seen that the industry sector is still determined as a driver of the long-term growth of the economy.

Table 3A.1. Structure of GDP by sectors over the period 2000 - 2010

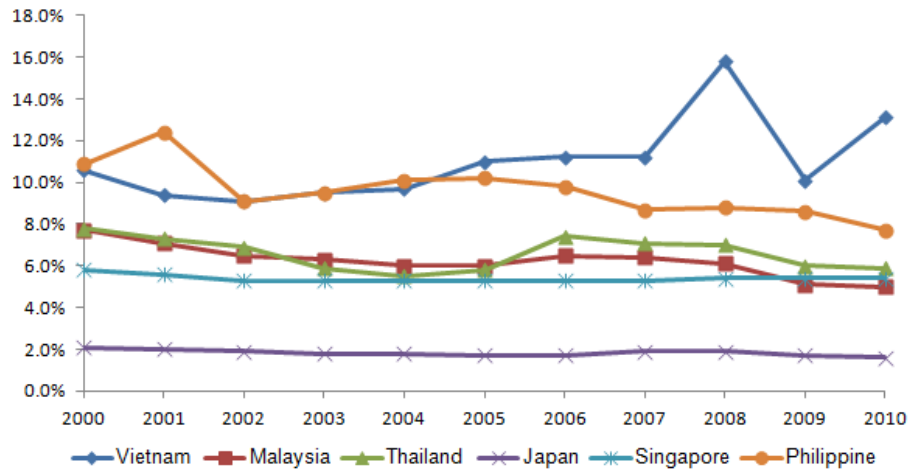
	2000	2002	2004	2006	2008	2010
Agriculture, value added (% of GDP)	24.5	23.0	21.8	20.4	22.2	20.6
Industry, value added (% of GDP)	36.7	38.5	40.2	41.5	39.8	41.1
Services, etc., value added (% of GDP)	38.7	38.5	38.0	38.1	37.9	38.3

(Source: Asian Development Bank 2012)

Interest rates

Interest rates have been gradually liberalized since the mid-1990s as the State Bank of Vietnam (SBV) determined ceilings for lending rates and floors for deposit rates. However, major steps towards market-determined interest rates were taken in August 2000. The ceilings for lending rates were replaced first by a basic interest rate, which was announced by the SBV every month. The maximum interest rate that commercial banks can offer in the market is 150% of the basic interest rate. According to the statistics of the World Bank (2012), the interest rate of countries in the Asia- Pacific region varied considerably and Vietnam's lending interest rate was relatively high in region in comparison with those of several countries (see Figure A3.2 below). This indicator might reduce competitive advantages of the country in attracting investors.

Figure A3.2. Lending interest rate, selected Asian economies over the period 2000 - 2010



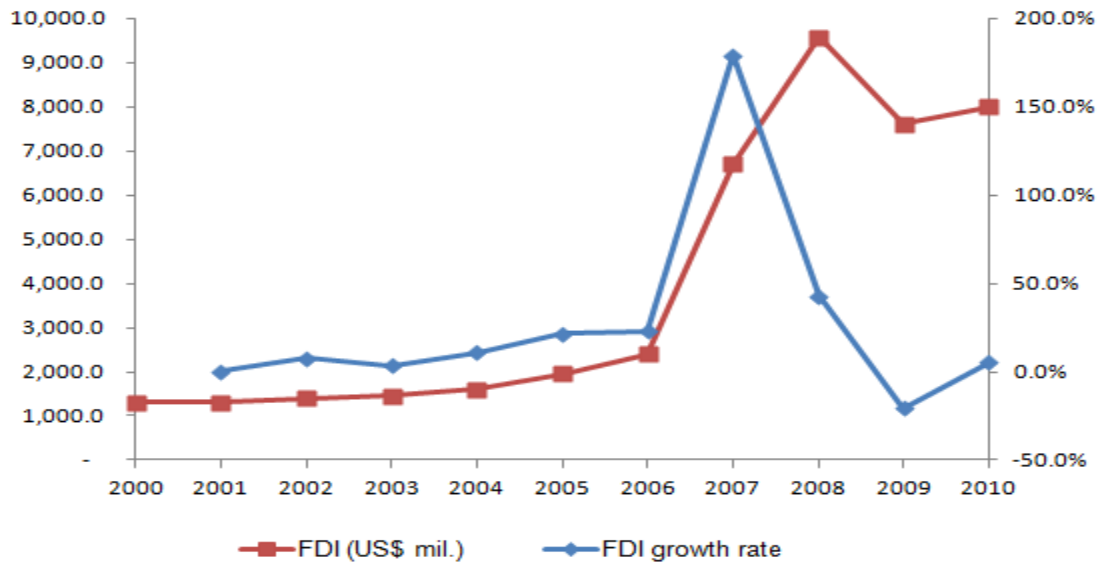
(Source: World Bank 2012)

Foreign direct investment

With several positive signals supporting for the development, the Foreign Direct Investment (FDI) of Vietnam has significantly increased in the last three consecutive years. Since the first years of the 21st century, the foreign investment capital flows has been gradually increasing, obtaining over US\$ 2.4 billion at the end of the 2006. Interestingly, a sharp increase in the FDI flows began in 2007 as Vietnam has officially become a 150th member of the World Trade Organization in January. The FDI flow moved nearly three times, up to US\$6.7 billion in 2007 and US\$ 9.6 billion in 2008 (see Figure A3.2 below).

With regard to foreign investors, some studies indicate that Korea, Singapore, Taiwan, Japan and Hong Kong are in top five investors of the country; whereas, the United State of America, France, Malaysia, Thailand, China and the United Kingdom are in a range of top fifteen countries (Van 2007; United Nation Conference on Trade and Development 2008). Thus, it can be seen that the large proportion of the foreign investment flows is derived from Asian countries.

Figure A3.3. FDI flows in Vietnam over the period 2000 – 2010



(Source: World Bank 2012)

In summary, over the last ten years, the Vietnamese economy has achieved significant results in terms of the economic growth rate as well as foreign direct investment. However, the economy has still confronted with much volatilities in its developments such as its high inflation rate and less attractive interest rates. These above economic indicators might cause both positive and negative effects to the development process of the country.

Appendix 3.2: Trading regulations in the Vietnamese equity market

Listing requirements

On the HOSE, a company may be accepted to trade on the market if it fulfils a number of quantity- and quality-listing criteria. The most important criteria are:

- Capital adequacy: A company must be a joint-stock company and have a registered capital no less than VND 10 billion at the time of submitting an application for listing.
- Profitability: A company must have made a profit for at least two consecutive years prior to its application and must not have any payable debt that is overdue by more than one year.
- Capital structure: At least 20 per cent of the capital of an applicant firm must be owned by at least 100 outside shareholders.
- Accounting practices: A company must abide by Vietnam's accounting standards and be audited by an auditing company authorised by the SSC.
- Information disclosures: A channel to disclose company information to the public must be approved by the HOSE.

Trading mechanisms

There are currently three trading methods employed on the HOSE at particular periods of time. The first method, known as a call-matching method, is executed twice per trading day in order to identify an opening and closing price. In this method, buyers and sellers send orders to an electronic centralised system on the HOSE via security-company supports. Buy and sell orders are matched periodically to determine executed prices.

The second method is a continuous-order-matching method, whereby buy and sell orders are matched automatically soon after the orders reach the systems. Both the call-matching and continuous-order-matching methods follow matching criteria in priority of (1) best price; (2) largest trading volume; (3) first come, first served; and (4) individual over institutional investors. The third method is trading by negotiation, which deals primarily with orders that trade large blocks of shares. This method is also known as a put-through trading mechanism. The method allows brokers to deal directly with each other to match orders given by their clients or themselves, and the executed price is determined by negotiation between two brokers. If the deal is matched, brokers are required to send details of negotiation results to the Vietnam Securities Depository for recording purposes.

Types of orders

Investors in the market can place four types of order: a limit order (LO), an ATO, an ATC and a market order (MO). Since the early trading days of the market, the LO was introduced, enabling buyers to limit the maximum price they are willing to pay and sellers to limit the minimum price they are willing to accept. In May 2003, ATO and ATC orders were introduced. Using these orders, buyers and sellers do not have to give prices on their orders but write the ATO/ATC on price columns. MOs allowing investors to trade at the best price available at the relevant time were introduced in 2007; however, they have not been officially used yet because of the high fluctuations in stock prices on the market in recent years.

Trading hours

Over the last 10 years, the trading hours for matching orders of stocks and investment fund certificates in the HOSE have adjusted several times, as follows:

Period	Trading days	Trading hours
28/7/2000–28/2/2002	Monday, Wednesday and Friday	8:00 a.m.–10:00 a.m.
1/3/2002–8/10/2007	Monday–Friday	Section 1: 9:00 a.m.–9:20 a.m. Section 2: 10:00 a.m.–10:30 a.m.
9/10/2007–13/10/2010	Monday–Friday	Section 1: 8:30 a.m.–9:00 a.m. ²⁰ Section 2: 9:00 a.m.–10:15 a.m. Section 3: 10:15 a.m.–10:30 a.m. Section 4: 10:30 a.m.–11:00 a.m.
14/10/2010–31/12/2010	Monday–Friday	Section 1: 8:30 a.m.–8:45 a.m. Section 2: 8:45 a.m.–10:30 a.m. Section 3: 10:30 a.m.–10:45 a.m.

Price-change limits

In the HOSE, daily stock-price variation is managed by the management board. Since 2000, the daily price-change limits have been revised several times within ± 7 per cent and ± 1 per cent for various reasons, such as reducing possible risks caused by recessions or overheated investor crowds, controlling herding behaviour and giving more freedom for price movements. Information on the previous changes of price limit on the HOSE can be seen in the table below.

Effective date	Limits (%)	Reasons
20 July 2000	± 5	Strict limit to prevent large shocks in price change
01 August 2000	± 2	Deal with emerged demand exceed supply
13 June 2001	± 7	High authority confidence in the maturity of investors
10 October 2001	± 2	Deal with four-month price drop
01 August 2002	± 3	Excite the market after the downward period
02 January 2003	± 5	Technical measure to encourage investors
27 March 2008	± 1	Minor negative effect of the continuous price drop
07 April 2008	± 2	Excite the market after it was stable
19 June 2008	± 3	Excite the market to encourage trading
18 August 2008	± 5	Excite the market to encourage trading

²⁰From 13 September 2007, the trading hours of section 1 and section 3 is decreased to 15 minutes each. Section 1 is from 8.30 am to 8.45 am. Section 2 is from 10.30 am to 10.45 am.

Trading costs

Investors have to pay three types of costs on the Vietnamese stock market: commission, interest and income tax. The commission is a fee that investors pay to a securities firm in order to execute orders and is calculated based on trading values. Since 2000, the SSC has determined a ceiling commission of 0.5 per cent of the trading value in accordance with the circular No. 01/2000/TT-UBCK of 17 April 2000. This fee varies from company to company and is considered a price policy of securities companies to attract investors. The second fee for investors who trade on the HOSE derives from collateral and repurchase services offered by securities companies. In particular, investors have to pay interest to securities companies when they take money in advance. However, depending on the length of time and the value of the borrowing, the investor incurs different interest rates; these rates are determined by the lending rates offered by commercial banks. The third fee type is a personal income tax imposed on securities transactions.

According to the LPIT, which was passed on 20 November 2008, investors must pay tax on income deriving from capital investments and capital transfers. However, regulations on the LPIT are usually revised by the government to support market development. For example, as a result of the effect of the GFC, a decision on stretching and exempting LPIT associated with securities trading until the end of 2010 was approved by Vietnam's National Assembly in May 2009. Such government policy not only encourages investors during periods of high volatility but also supports the long-term development of the market.

Appendix 3.3: Equity-market indicators by country, 2003–2010

	2003	2004	2005	2006	2007	2008	2009	2010
Market capitalisation of listed companies (% of GDP)								
Hong Kong	347.63	401.03	390.10	471.35	561.39	617.01	1,094.96	1,207.9
India	46.56	53.75	66.31	86.08	146.42	53.18	85.41	93.46
Japan	71.90	79.86	104.05	108.34	101.73	66.00	67.12	74.57
Korea, Rep.	51.20	59.37	85.01	87.75	107.09	53.11	100.29	107.37
Malaysia	152.79	152.31	131.47	150.36	174.49	84.33	132.55	172.64
Singapore	246.04	252.59	252.48	190.14	199.34	95.06	169.51	166.18
Thailand	84.99	72.33	70.80	68.13	79.38	37.64	52.40	87.11
UK	132.20	127.85	134.12	155.24	137.27	69.69	128.68	138.33
US	128.65	138.19	134.91	145.66	142.53	82.10	107.36	117.53
Vietnam	0.39	0.55	0.87	14.92	27.48	10.62	21.82	19.68
Market capitalisation of listed companies (current US\$b)								
Hong Kong	551.2	665.2	693.5	895.2	1,162.6	1,328.8	2,291.6	2,711.3
India	279.1	387.9	553.1	818.9	1,819.1	645.5	1,179.2	1,615.9
Japan	3,040.7	3,678.3	4,736.5	4,726.3	4,453.5	3,220.5	3,377.9	4,099.6
Korea, Rep.	329.6	428.6	718.2	835.2	1,123.6	494.6	836.5	1,089.2
Malaysia	168.4	190.0	181.2	235.4	325.7	187.1	256.0	410.5
Singapore	229.3	277.0	316.7	276.3	353.5	180.0	310.8	370.1
Thailand	121.2	116.7	124.9	141.1	196.0	102.6	138.2	277.7
UK	2,460	2,815	3,058	3,794	3,858	1,852	2,796	3,107
US	14,266.3	16,323.7	16,970	19,425	19,947.3	11,737.6	15,077.3	17,139
Vietnam	0.2	0.2	0.5	9.1	19.5	9.6	21.2	20.4
Stocks traded, total value (% of GDP)								
Hong Kong	153.6	169.7	165.4	212.6	442.8	755.1	711.8	711.7
India	47.5	52.5	52.0	67.1	89.1	86.5	78.9	61.1
Japan	53.7	74.5	109.8	143.3	148.4	120.5	83.3	77.9
Korea, Rep.	106.0	88.5	142.4	140.8	188.1	157.4	189.6	160.3
Malaysia	45.5	48.0	36.3	42.7	80.4	38.4	37.8	37.9
Singapore	94.3	74.1	95.5	126.9	216.7	143.0	137.6	126.7
Thailand	67.7	67.6	50.6	48.7	43.8	42.8	51.2	68.4
UK	118.8	168.3	182.8	173.6	367.3	244.1	156.6	133.9
US	140.2	163.9	171.0	249.5	304.5	255.1	332.8	208.8
Vietnam	0.0	0.1	0.2	1.8	17.7	4.6	6.8	28.4
Stocks traded, total value (current US\$b)								
Hong Kong	243.6	281.6	294.1	403.9	916.9	1626.1	1489.6	1597.5
India	284.8	379.1	433.9	638.5	1107.6	1049.7	1088.9	1056.8
Japan	2273.0	3430.4	4997.4	6252.5	6497.2	5879.4	4192.6	4280.4
Korea, Rep.	682.7	638.9	1203.0	1340.1	1974.0	1466.0	1581.5	1626.6
Malaysia	50.1	59.9	50.0	66.9	150.0	85.2	73.0	90.2
Singapore	87.9	81.3	119.8	184.4	384.2	270.9	252.3	282.1
Thailand	96.6	109.1	89.3	100.8	108.2	116.8	134.9	217.9
UK	2211.5	3707.2	4167.0	4242.1	10324.5	6487.0	3402.5	3006.7
US	15547.4	19354.9	21510.0	33267.6	42613.2	36467.4	46735.9	30454.8
Vietnam	0.0	0.1	0.1	1.1	12.6	4.2	6.7	29.4

Appendix 4.1: Results of unit root tests on the selected market levels and returns

	Advanced markets						Emerging markets		
	HK	JP	KR	SG	TW	US	ML	TL	VN
A. Market level									
Entire period									
ADF	-1.08	-1.97	-0.69	-0.76	-1.67	-2.04	-0.22	-1.12	-1.95
Lag	0	0	0	0	0	2	1	0	4
PP	-1.00	-1.84	-0.69	-0.83	-1.75	-2.13	-0.28	-1.18	-2.06
Lag	7	11	3	9	2	3	13	5	26
Pre-crisis period									
ADF	-0.72	-1.63	-0.78	-0.64	-1.85	-1.72	-0.81	-1.48	-1.53
Lag	0	0	0	0	0	1	3	0	5
PP	-0.69	-1.58	-0.76	-0.68	-1.91	-1.64	-0.78	-1.48	-1.63
Lag	4	4	5	7	8	18	11	0	22
Post-crisis period									
ADF	-3.04	-3.25	-2.86	-3.27	-3.65	-2.56	-2.12	-1.63	-3.60*
Lag	0	0	0	0	0	0	1	0	1
PP	-3.09	-3.23	-3.01	-3.23	-3.63	-23.64	-2.14	-1.64	-3.73*
Lag	6	3	12	3	4	0	3	1	6
B. Market return									
Entire period									
ADF	-53.92*	-39.53*	-51.49*	-51.30*	-50.19*	-41.53*	-44.54*	-34.06*	-21.34*
Lag	0	1	0	0	0	1	0	1	3
PP	-53.97*	-53.19*	-51.49*	-51.35*	-50.19*	-57.52*	-44.85*	-51.74*	-44.66*
Lag	7	12	4	8	1	5	10	5	24
Pre-crisis period									
ADF	-47.20*	-47.20*	-45.31*	-45.44*	-44.57*	-48.78*	-23.25*	-30.32*	-16.01*
Lag	0	0	0	0	0	0	2	1	4
PP	-47.20*	-47.24*	-45.31*	-45.46*	-44.57*	-49.05*	-39.21*	-45.85*	-39.91*
Lag	4	4	6	7	10	18	8	0	19
Post-crisis period									
ADF	-22.12*	-22.47*	-21.95*	-21.09*	-20.27*	-23.64*	-18.88*	-22.56*	-17.38*
Lag	0	0	0	0	0	0	0	0	0
PP	-22.12*	-22.47*	-22.03*	-21.09*	-20.25*	-23.69*	-18.87*	-22.56*	-17.23*
Lag	3	2	9	2	0	3	1	1	4

Notes: The critical values for both the ADF and PP tests are -3.44, -2.89 and -2.57 at 1 per cent, 5 per cent and 10 per cent respectively. An intercept is included in the test equation for both tests. * denotes the rejection of the null hypothesis at a 1 per cent level of significance.

Appendix 5.1: Results of the variance decomposition among the emerging and advanced market returns

A. Emerging markets

Markets	Period	Entire period			Pre-crisis period			Post-crisis period		
		ML	TL	VN	ML	TL	VN	ML	TL	VN
ML	1	100.00	–	–	100.00	–	–	100.00	–	–
	2	99.99	0.00	0.01	99.97	0.00	0.03	100.00	–	–
	3	99.99	0.00	0.01	99.96	0.00	0.04	100.00	–	–
	4	99.99	0.00	0.01	99.96	0.00	0.04	100.00	–	–
TL	1	13.95	86.05	–	10.75	89.25	–	0.36	99.64	–
	2	15.66	84.34	0.00	11.89	88.03	0.08	0.36	99.64	–
	3	16.40	83.60	0.00	12.34	87.52	0.14	0.36	99.64	–
	4	16.78	83.22	0.00	12.57	87.26	0.18	0.36	99.64	–
VN	1	0.33	0.25	99.42	0.00	0.02	99.97	3.01	1.21	95.78
	2	1.35	0.25	98.40	0.21	0.02	99.77	3.01	1.21	95.78
	3	1.48	0.25	98.27	0.24	0.02	99.74	3.01	1.21	95.78
	4	1.49	0.25	98.26	0.24	0.02	99.73	3.01	1.21	95.78

B. Advanced markets

Markets	Period	Entire period						Pre-crisis period						Post-crisis period					
		US	HK	JP	KR	SG	TW	US	HK	JP	KR	SG	TW	US	HK	JP	KR	SG	TW
US	1	100.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
	2	94.68	4.08	0.30	0.19	0.74	0.00	97.38	1.24	0.59	0.17	0.62	0.00	99.63	0.08	0.09	0.10	0.00	0.11
	3	94.21	4.08	0.26	0.26	1.15	0.02	96.82	1.42	0.64	0.22	0.91	0.00	98.84	0.24	0.28	0.30	0.00	0.35
	4	93.82	4.31	0.27	0.29	1.28	0.02	96.48	1.54	0.69	0.23	1.04	0.00	97.69	0.47	0.55	0.59	0.00	0.69
HK	1	18.05	81.95	0.00	0.00	0.00	0.00	19.33	80.67	0.00	0.00	0.00	0.00	15.48	84.52	0.00	0.00	0.00	0.00
	2	19.45	78.81	0.03	0.24	1.25	0.23	20.96	77.93	0.04	0.15	0.68	0.23	14.76	85.21	0.01	0.01	0.00	0.01
	3	19.92	77.97	0.04	0.28	1.51	0.28	21.52	77.11	0.05	0.19	0.84	0.30	14.11	85.80	0.03	0.03	0.00	0.03
	4	20.14	77.57	0.04	0.30	1.64	0.31	21.97	76.52	0.06	0.21	0.91	0.34	13.52	86.30	0.05	0.06	0.00	0.07
JP	1	23.86	17.12	59.02	0.00	0.00	0.00	15.62	16.35	68.03	0.00	0.00	0.00	33.75	15.75	50.50	0.00	0.00	0.00
	2	24.58	20.67	53.20	0.11	1.36	0.08	16.77	17.96	64.27	0.13	0.85	0.02	33.74	15.76	50.51	0.00	0.00	0.00
	3	25.19	21.05	51.77	0.14	1.74	0.11	17.39	18.04	63.30	0.17	1.07	0.03	33.73	15.76	50.51	0.00	0.00	0.00
	4	25.38	21.37	51.05	0.16	1.91	0.13	17.92	17.98	62.70	0.19	1.16	0.05	33.72	15.76	50.52	0.00	0.00	0.00
KR	1	12.32	24.30	7.18	56.20	0.00	0.00	12.91	21.03	6.66	59.40	0.00	0.00	13.31	25.79	12.01	48.89	0.00	0.00
	2	13.03	23.95	6.18	55.95	0.88	0.01	13.32	20.90	6.16	59.26	0.35	0.00	13.82	25.62	11.83	48.72	0.00	0.00
	3	13.31	23.64	5.86	56.02	1.14	0.03	13.67	20.51	5.94	59.44	0.43	0.01	14.30	25.47	11.66	48.56	0.00	0.01
	4	13.44	23.45	5.68	56.08	1.31	0.05	14.02	20.16	5.77	59.56	0.46	0.01	14.75	25.32	11.50	48.40	0.00	0.03
SG	1	14.30	35.43	1.67	2.43	46.18	0.00	15.10	28.66	2.39	2.26	51.60	0.00	10.24	48.73	0.71	0.15	40.17	0.00
	2	15.06	31.32	1.17	2.71	49.66	0.09	14.60	25.44	1.96	2.54	55.30	0.15	9.65	49.33	0.83	0.21	39.96	0.01
	3	15.20	30.49	1.07	2.78	50.37	0.10	14.74	24.20	1.81	2.62	56.43	0.20	9.13	49.86	0.95	0.28	39.75	0.04
	4	15.30	30.11	1.02	2.82	50.66	0.09	15.06	23.43	1.71	2.70	56.86	0.24	8.66	50.32	1.07	0.35	39.53	0.07
TW	1	9.70	14.08	2.32	7.66	1.30	64.94	9.30	10.11	2.17	7.28	1.14	70.00	14.84	25.11	3.79	7.23	2.97	46.06
	2	11.20	18.20	2.20	8.14	3.17	57.09	11.08	13.04	2.50	8.35	2.02	63.01	15.13	25.04	3.72	7.15	2.98	45.98
	3	11.86	18.90	2.08	8.41	4.06	54.68	11.96	13.50	2.48	8.86	2.41	60.79	15.40	24.98	3.66	7.07	2.99	45.90
	4	12.17	19.26	2.02	8.53	4.55	53.47	12.63	13.59	2.44	9.15	2.56	59.63	15.66	24.92	3.61	7.00	3.00	45.82

Appendix 5.2: Results of the impulse response function among the emerging and advanced markets

A. Emerging markets

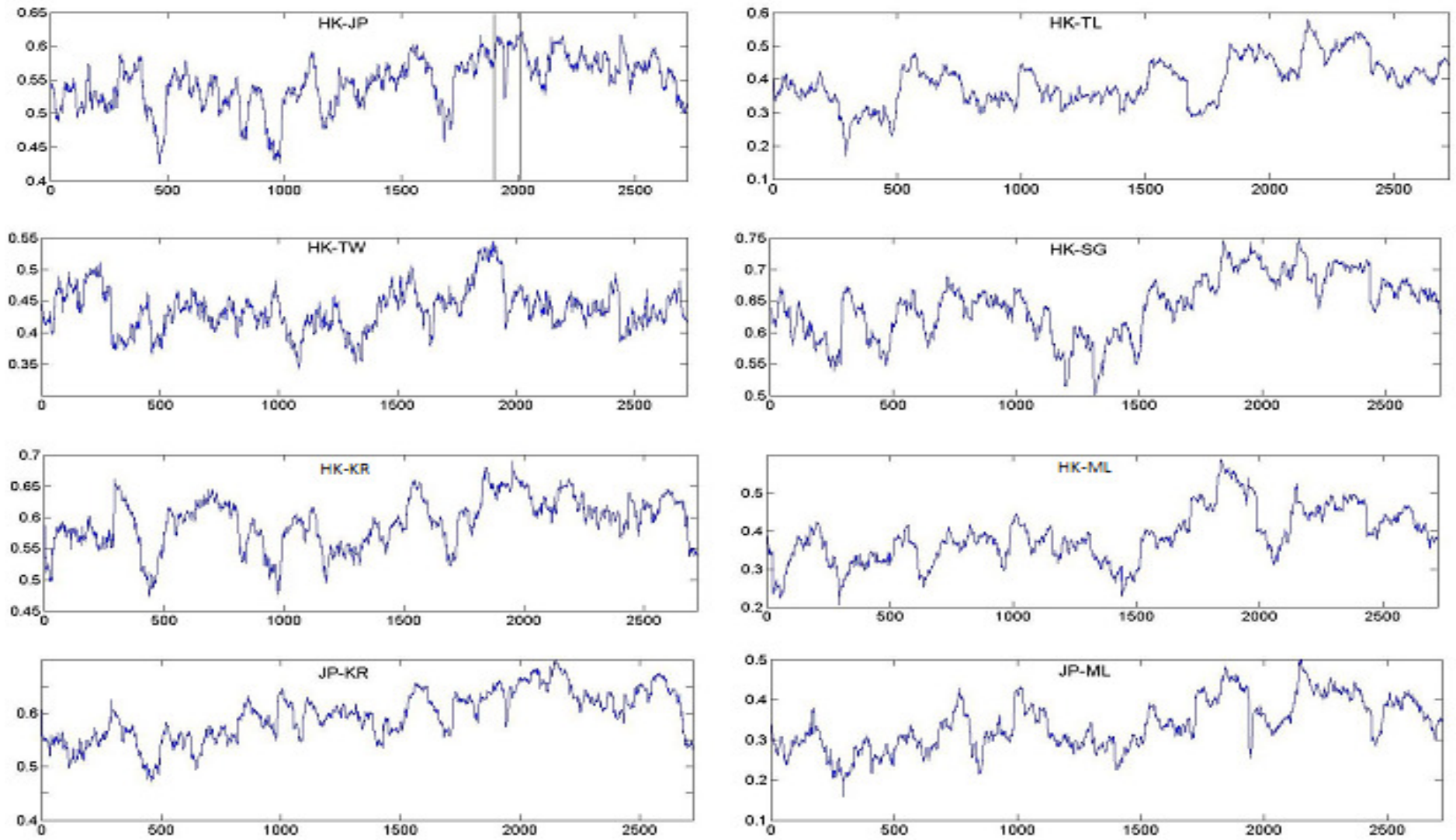
Market	Period	ML	TL	VN
Entire period				
ML	1	0.8624	0.3227	0.0465
	2	0.9972	0.4216	0.0466
	3	1.0168	0.4343	0.0443
	4	1.0195	0.4360	0.0434
	5	1.0198	0.4361	0.0432
TL	1	0.5326	1.4233	0.0979
	2	0.6035	1.4373	0.0991
	3	0.6146	1.4457	0.0987
	4	0.6161	1.4467	0.0984
	5	0.6163	1.4468	0.0983
VN	1	0.0875	0.1116	1.6228
	2	0.2571	0.2757	2.0105
	3	0.3188	0.3276	2.1002
	4	0.3364	0.3418	2.1205
	5	0.3409	0.3454	2.1251
Pre-crisis period				
ML	1	0.8781	0.2882	0.0041
	2	1.0170	0.3773	−0.0110
	3	1.0374	0.3894	−0.0189
	4	1.0402	0.3910	−0.0214
	5	1.0405	0.3912	−0.0220
TL	1	0.4386	1.3364	0.0220
	2	0.4869	1.3382	−0.0324
	3	0.4923	1.3419	−0.0454
	4	0.4925	1.3420	−0.0486
	5	0.4924	1.3419	−0.0493
VN	1	0.0073	0.0257	1.5580
	2	0.0799	0.0730	1.9192
	3	0.1075	0.0905	2.0008
	4	0.1155	0.0955	2.0189
	5	0.1176	0.0967	2.0229
Post-crisis period				
ML	1	0.6406	0.2826	0.1112
TL	1	0.5662	1.2831	0.1176
VN	1	0.3071	0.1621	1.7686

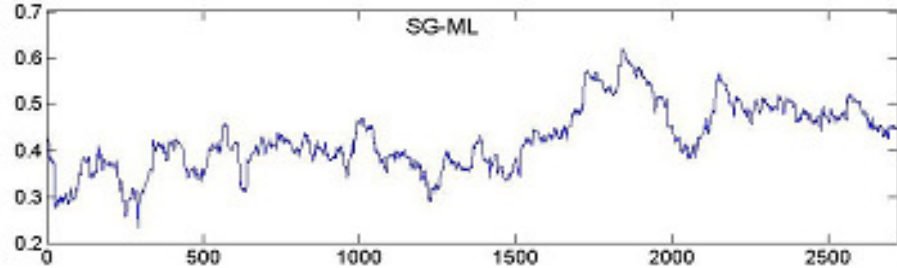
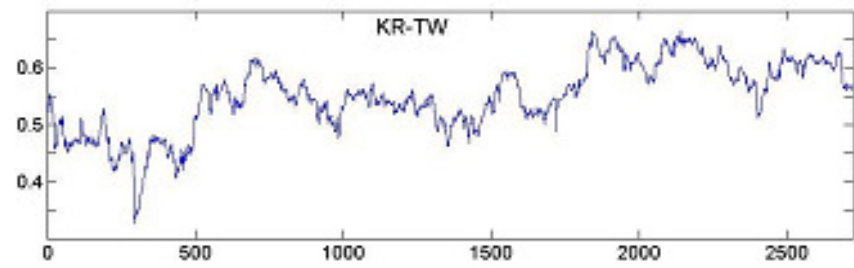
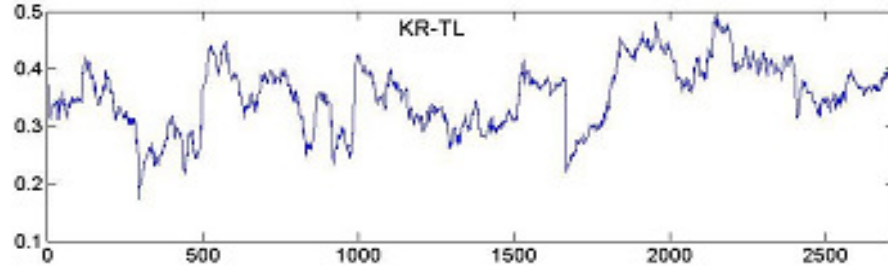
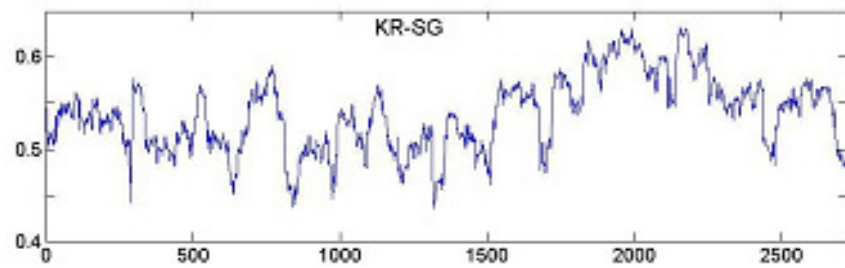
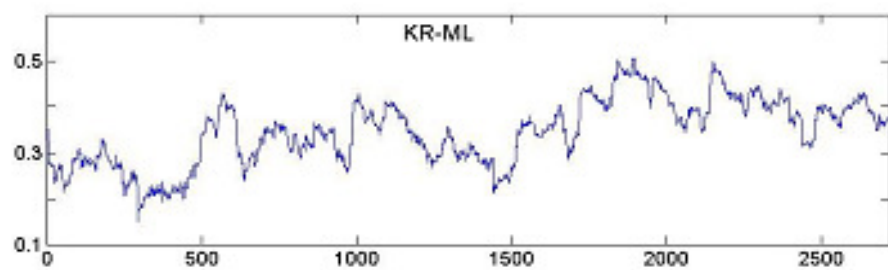
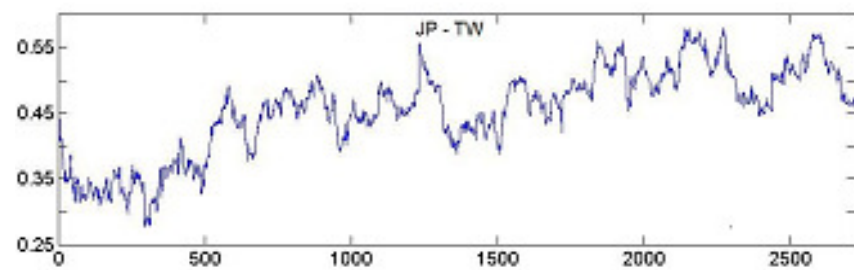
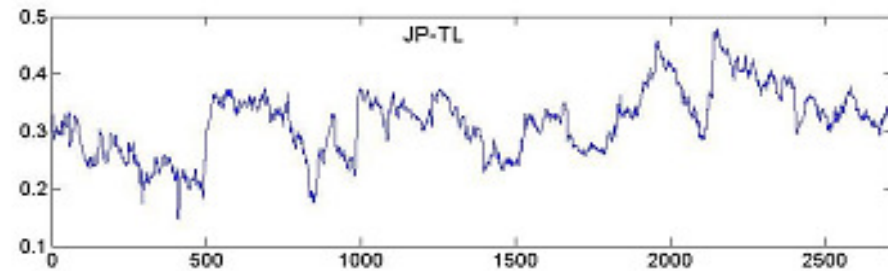
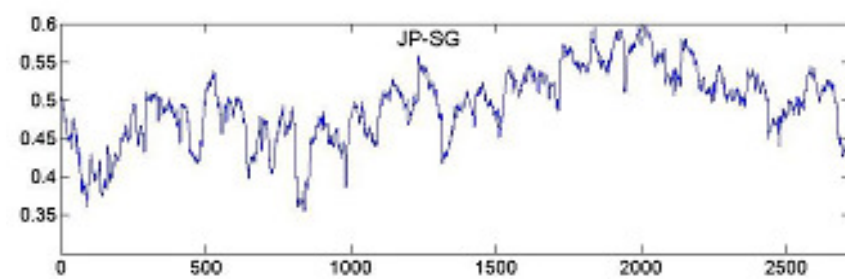
B. Advanced markets

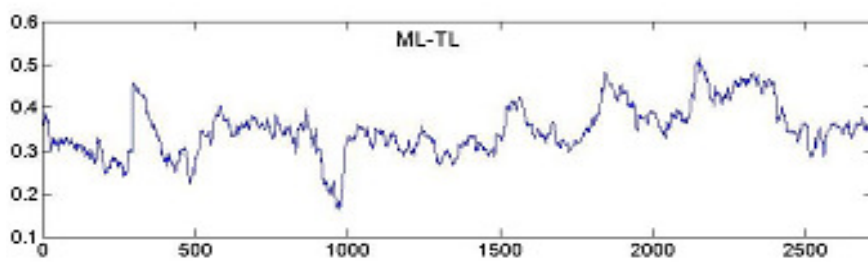
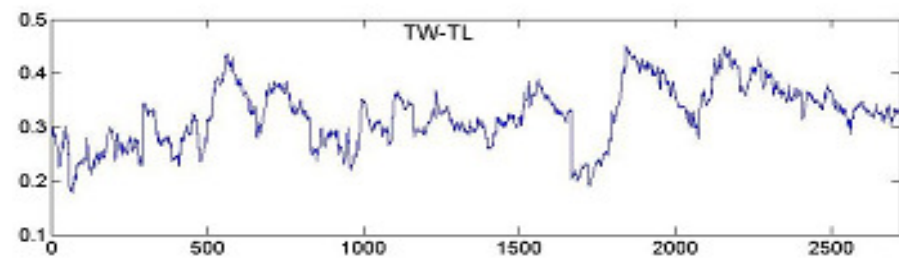
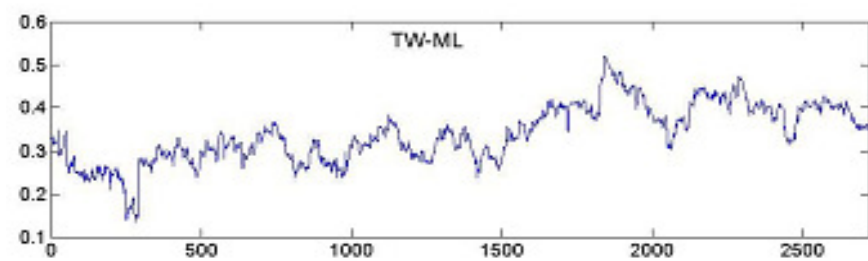
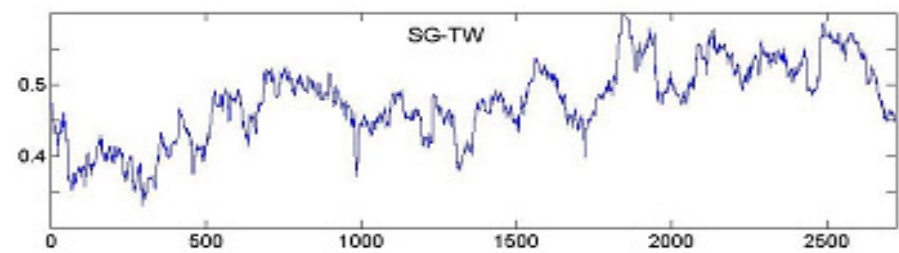
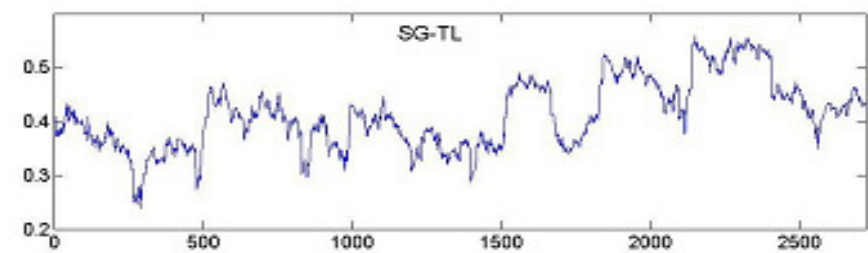
Market	Period	US	HK	JP	KR	SG	TW
Entire period							
US	1	0.0127	0.0054	0.0062	0.0045	0.0048	0.0040
	2	0.0245	0.0137	0.0142	0.0112	0.0127	0.0094
	3	0.0367	0.0212	0.0216	0.0175	0.0202	0.0144
	4	0.0487	0.0288	0.0292	0.0239	0.0277	0.0196
	5	0.0608	0.0364	0.0367	0.0302	0.0353	0.0247
HK	1	0.0067	0.0157	0.0091	0.0094	0.0110	0.0074
	2	0.0138	0.0309	0.0179	0.0192	0.0235	0.0144
	3	0.0208	0.0460	0.0266	0.0288	0.0357	0.0212
	4	0.0277	0.0611	0.0352	0.0385	0.0479	0.0281
	5	0.0347	0.0761	0.0439	0.0481	0.0601	0.0349
JP	1	0.0075	0.0090	0.0154	0.0090	0.0082	0.0065
	2	0.0153	0.0192	0.0306	0.0189	0.0189	0.0135
	3	0.0232	0.0290	0.0456	0.0285	0.0292	0.0202
	4	0.0310	0.0389	0.0606	0.0382	0.0396	0.0269
	5	0.0388	0.0487	0.0756	0.0479	0.0500	0.0336
KR	1	0.0058	0.0099	0.0096	0.0166	0.0096	0.0090
	2	0.0121	0.0200	0.0191	0.0333	0.0208	0.0182
	3	0.0183	0.0299	0.0284	0.0499	0.0319	0.0271
	4	0.0245	0.0397	0.0376	0.0664	0.0429	0.0359
	5	0.0307	0.0495	0.0467	0.0828	0.0539	0.0445
SG	1	0.0048	0.0089	0.0068	0.0074	0.0128	0.0061
	2	0.0100	0.0173	0.0130	0.0145	0.0257	0.0118
	3	0.0151	0.0258	0.0192	0.0217	0.0386	0.0175
	4	0.0202	0.0342	0.0255	0.0289	0.0515	0.0232
	5	0.0253	0.0427	0.0319	0.0362	0.0643	0.0290
TW	1	0.0047	0.0071	0.0064	0.0082	0.0073	0.0151
	2	0.0103	0.0162	0.0140	0.0179	0.0172	0.0307
	3	0.0159	0.0249	0.0212	0.0274	0.0270	0.0459
	4	0.0215	0.0336	0.0284	0.0367	0.0368	0.0610
	5	0.0271	0.0422	0.0355	0.0460	0.0466	0.0760
Pre-crisis period							
US	1	0.0106	0.0046	0.0042	0.0038	0.0041	0.0032
	2	0.0205	0.0105	0.0097	0.0089	0.0099	0.0073
	3	0.0305	0.0161	0.0149	0.0137	0.0157	0.0112
	4	0.0403	0.0217	0.0202	0.0186	0.0214	0.0151
	5	0.0502	0.0273	0.0254	0.0234	0.0271	0.0190
HK	1	0.0059	0.0134	0.0072	0.0077	0.0088	0.0056
	2	0.0122	0.0265	0.0140	0.0157	0.0185	0.0108
	3	0.0184	0.0394	0.0208	0.0235	0.0280	0.0158
	4	0.0247	0.0523	0.0275	0.0314	0.0376	0.0208
	5	0.0311	0.0652	0.0342	0.0392	0.0471	0.0259
JP	1	0.0054	0.0073	0.0136	0.0073	0.0068	0.0050
	2	0.0110	0.0151	0.0267	0.0153	0.0151	0.0103
	3	0.0167	0.0226	0.0398	0.0231	0.0232	0.0154
	4	0.0225	0.0302	0.0528	0.0309	0.0312	0.0205
	5	0.0285	0.0377	0.0658	0.0387	0.0393	0.0256
KR	1	0.0059	0.0093	0.0088	0.0163	0.0088	0.0082
	2	0.0120	0.0187	0.0175	0.0327	0.0187	0.0164
	3	0.0182	0.0280	0.0261	0.0491	0.0284	0.0246
	4	0.0246	0.0373	0.0346	0.0655	0.0382	0.0327

Market	Period	US	HK	JP	KR	SG	TW
SG	5	0.0311	0.0466	0.0432	0.0819	0.0478	0.0408
	1	0.0044	0.0074	0.0057	0.0062	0.0114	0.0049
	2	0.0088	0.0142	0.0108	0.0121	0.0229	0.0091
	3	0.0132	0.0209	0.0158	0.0179	0.0342	0.0132
	4	0.0177	0.0276	0.0208	0.0238	0.0454	0.0174
TW	5	0.0224	0.0342	0.0258	0.0297	0.0567	0.0215
	1	0.0046	0.0063	0.0056	0.0075	0.0065	0.0151
	2	0.0102	0.0143	0.0124	0.0167	0.0149	0.0305
	3	0.0159	0.0221	0.0190	0.0258	0.0234	0.0457
	4	0.0218	0.0298	0.0256	0.0349	0.0317	0.0609
Post-crisis period	5	0.0278	0.0376	0.0322	0.0441	0.0401	0.0762
	1	0.0130	0.0051	0.0075	0.0047	0.0042	0.0050
	2	0.0253	0.0104	0.0153	0.0100	0.0085	0.0107
	3	0.0370	0.0159	0.0232	0.0159	0.0131	0.0169
	4	0.0483	0.0215	0.0312	0.0222	0.0178	0.0236
US	5	0.0591	0.0273	0.0394	0.0288	0.0227	0.0308
	1	0.0061	0.0155	0.0092	0.0095	0.0119	0.0095
	2	0.0119	0.0310	0.0185	0.0191	0.0239	0.0192
	3	0.0175	0.0467	0.0278	0.0290	0.0359	0.0292
	4	0.0229	0.0624	0.0372	0.0391	0.0480	0.0394
HK	5	0.0282	0.0781	0.0466	0.0493	0.0602	0.0497
	1	0.0083	0.0085	0.0143	0.0094	0.0075	0.0080
	2	0.0166	0.0170	0.0286	0.0189	0.0150	0.0161
	3	0.0250	0.0255	0.0430	0.0284	0.0225	0.0241
	4	0.0333	0.0340	0.0573	0.0378	0.0300	0.0321
JP	5	0.0416	0.0425	0.0716	0.0473	0.0374	0.0402
	1	0.0041	0.0069	0.0075	0.0114	0.0060	0.0074
	2	0.0084	0.0138	0.0150	0.0226	0.0120	0.0147
	3	0.0128	0.0207	0.0224	0.0338	0.0179	0.0219
	4	0.0173	0.0276	0.0298	0.0449	0.0238	0.0289
KR	5	0.0218	0.0344	0.0372	0.0559	0.0296	0.0359
	1	0.0039	0.0094	0.0064	0.0064	0.0122	0.0074
	2	0.0076	0.0188	0.0128	0.0130	0.0245	0.0151
	3	0.0111	0.0283	0.0193	0.0198	0.0368	0.0229
	4	0.0145	0.0378	0.0258	0.0267	0.0492	0.0309
SG	5	0.0177	0.0474	0.0324	0.0338	0.0616	0.0390
	1	0.0048	0.0076	0.0070	0.0081	0.0076	0.0125
	2	0.0097	0.0152	0.0140	0.0161	0.0151	0.0248
	3	0.0146	0.0228	0.0209	0.0241	0.0227	0.0372
	4	0.0196	0.0304	0.0278	0.0321	0.0302	0.0494
TW	5	0.0246	0.0380	0.0348	0.0400	0.0377	0.0617

Appendix 5.3: Dynamic conditional correlation between pairs of markets







Appendix 6.1: Summary of results of the long-run relationships between Vietnam and other markets

Model	Whole period			Pre-crisis period			Post-crisis period		
	1	2*	3	1	2*	3	1	2*	3
Advanced markets									
VN-HK	✓	✓	✓	✓		✓			✓
VN-JP		✓	✓	✓	✓	✓	✓		✓
VN-KR		✓						✓	✓
VN-SG	✓		✓	✓		✓			✓
VN-TW	✓		✓	✓	✓	✓			✓
VN-US	✓	✓	✓	✓		✓		✓	
Emerging markets									
VN-ML									
VN-TL					✓			✓	

Notes: Model 1 is the co-integration tests based on residuals. Model 2 is the co-integration tests with the presence of structural breaks and model 3 is the co-integration tests based on the VAR model. * denote the combinations of results in both the model with breaks in intercept and the model with breaks in intercept and trend.

Appendix 6.2: Results of co-integration between pairs of markets

Market	HK	JP	KR	SG	TW	US	ML	TL
Entire sample period								
HK				1, 2	1, 3	2	1	
JP								
KR					1, 2, 3		1, 3	2
SG	1, 2				1, 2, 3		2	
TW	1		1	1, 2		2	1, 2, 3	1, 2, 3
US								
ML			1		1, 2			2
TL					1			
Pre-crisis period								
HK				1	1, 2		2	
JP						1		
KR					1, 3		1	
SG	1				1, 2, 3	2		
TW	1	2	1, 2	1, 2		2	1, 2, 3	1, 2, 3
US		1		1, 2	2			
ML	2		1		1, 2			
TL	2	2	2	2	1, 2	2	2	
Post-crisis period								
HK		3		2, 3	1, 2, 3	3	1, 3	2
JP			2, 3	2, 3	2, 3		1, 2	1, 2
KR		2		2, 3	2, 3	2, 3	1, 2, 3	1, 2, 3
SG	2, 3				1, 2, 3	3	1, 2, 3	
TW	1	2	2	1		1, 3	1, 2, 3	1, 2, 3
US	2		2	1, 2	1, 2		1, 2, 3	
ML	2		1	1, 2	1	1		1, 2, 3
TL	2		1		1, 2	2	1	

Notes: 1 denotes co-integration tests based on residuals, 2 denotes co-integration tests with the presence of structural breaks and 3 denotes co-integration tests based on the VAR model. 2 combines the results in both the model with breaks in intercept and the model with breaks in intercept and trend.